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Aircraft Identification in High Resolution Remote Sensing Images using Shape Analysis

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ABSTRACT: Automatic aircraft recognition in a complex environment has long been an interesting and challenging task. Conventional aircraft recognition methods always extract the overall shape features of aircraft for recognition, which is too idealistic for targets in remote sensing images. In this letter, an aircraft recognition system is proposed that provides the best way to recognize the aircraft robustly without perfect extractions of shape as a precondition. This recognition system involves dimensionality reduction, segmentation and aircraft identification with templates. Specifically, a principal component analysis is proposed to reduce the dimensionality of the satellite image. Then, histogram probability thresholding is used to detect the desired object from background. Connected component analysis is used here to extract the local object shape descriptors for identifying desired target. Template is used as a matching model. Finally, correlation measurement is used for measuring similarity between two object region features and simulation demonstrated that the capability of object tracking in remote sensing images with help of used approaches.

KEY WORDS: Dimensionality reduction, Segmentation, Aircraft identification.

I. INTRODUCTION

To identify the types of aircraft is very challenging. Aircraft recognition is an important issue of target recognition in satellite images and it has many applications in practice such as airfield dynamic surveillance and navigation. We can detect the unusual trends and activity patterns of aircraft for recognition. However, aircraft identification with high resolution remote sensing images is challenging task. It is still difficult to differentiate targets of some types from the others.

Aircraft identification is different from other object identification [3]. The number of aircraft type is limited and each type of aircraft has fixed size and space features. Consider the above criterion, we can build template for each type of aircraft and match the target to the different types of templates. In this paper, mainly concentrates on how to measure the similarity between targets independent of overall shape extraction. The advantage of this method is it can identify aircraft strenuously without perfect extraction of outline or shape of objects as a precondition. It also deals with the condition of parts missing and shadow disturbance.

The identification method consists of three processes: Potentially moving objects are first identified on time-series images. The target is then modelled by extracting both spectral and spatial features. In the target matching procedure template is used as matching model to recognize an aircraft for accurate detection. We evaluate this method using panchromatic 0.6-m resolution quickbird imagery, and the simulation results shows that the method proposed is accurate and effective.

II. RELATED WORK

In conventional aircraft identification methods are based on rotation invariant features after binarization [4]. These methods use thresholding segmentation [7] for overall silhouette or shape of objects, and extract rotation invariant features such as Hu moments [2], Zernike moments [10], Wavelet moments and Fourier descriptors for identification. These methods have some drawbacks : obtaining the fourier descriptors and moment invariants needs perfect extraction of shape of each aircraft as a precondition, which is too difficult for targets with irregular appearance provided by low SNR, distortion in satellite images and these methods do not make full use of the spectral and shape characteristics of aircraft for target localization.

There are also few identification methods which estimate the direction first after binarization [1],and then identify the type of aircraft. These methods also need the binary image of each aircraft types as a precondition for direction estimation, which decreases the practicability. As aircraft identification is still a challenging problem. Object tracking in complex environment has long been a challenging and interesting problem [5] . Aircraft recognition is an important issue of target recognition in satellite images and it has many applications in practice such as airfield dynamic surveillance. Automatic aircraft recognition is not a very simple problem. Apart from the complex structure, different aircraft differ in size, shape colour, texture and intensity. It is usually dissimilar in different scenarios. Moreover, object recognition often suffers from various disturbances such as different contrasts, clutter and intensity in homogeneity [6]. Thus, the resistance to disturbance and robustness are highly required for object recognition.

III. Proposed Algorithm

A. Dimensionality Reduction

Dimensionality reduction is the process of reducing the number of random variables present in the object. Feature selection and Feature extraction are the two process in this method.

i) Algorithm flow for PCA :

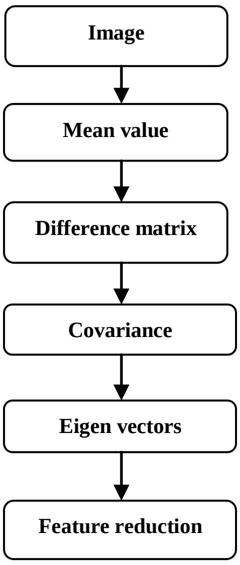

Fig. 1 Flow of dimensionality reduction process

Feature selection tries to find a subset of the original variable. Feature extraction converts the data in high dimensions to fewer dimensions. In this paper, Principal Component Analysis (PCA) is used for reducing the dimensionality of the image. Principal component analysis is a mathematical procedure that uses an orthogonal transformation to transform a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables.
ii) PCA steps:

1. Input
2. Subtract mean

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3. Calculate covariance matrix
4. Calculate eigen vectors and eigen values of the covariance matrix
5. Choosing components and forming a feature vector
6. Deriving the new data set

The singular value decomposition of X is X=WV^T, where W is the eigenvectors of the covariance matrix X, X is an m x n rectangular diagonal matrix with nonnegative real numbers on the diagonal, V is the eigenvectors of $X^T X$. The PCA transformation the preserves dimensionality is given by,

$$\mathrm{Y}Y^T = X^T W = W^T V W = V$$

where Y^T *is simply a rotation of* X^T.The first column of Y^T is made up of the scores with respect to the principal component, the next column has the scores with respect to the second principal component.

B. Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyse. It is typically used to locate objects and boundaries in images such that pixels with the same label share certain characteristics.

To partition an image into nonintersecting regions the nonparametric and unsupervised otsu's thresholding method is considered in this paper. Otsu's method is used to automatically perform clustering based image thresholding or reduction of graylevel image to a binary image. The algorithm assumes that image contains two classes of pixels following bi-modal histogram (foreground pixels & background pixels) it then calculates the optimum threshold separating the two classes so that their intra class variance is minimal, inter class variance is maximal.

The key concept behind this method is to obtain an optimal threshold that maximizes a function of the threshold level. The optimal threshold is selected by a criterion, in order to maximize the separability of resultant classes in gray levels. The procedure utilizes only the zeroth and the first-order cumulative moments of gray level histogram.Thresholding is a simple form of segmentation. In thresholding, every pixel in an image is compared with the threshold value. If the pixel lies above the threshold it will be marked as foreground and if it is below threshold as background. The threshold will most often be intensity or color value. In this method the selection of initial threshold value is depends upon the histogram of an image and the gray scale of an image.

C. Aircraft Identification

i) Local region descriptors

After the segmentation, connected component analysis is performed for the segmented local regions to group the similar property objects. Each object region will be described by evaluating the following characteristics,

1) Area
2) Equivalent diameter
3) Width and height
4) Orientation
5) Perimeter
6) Eccentricity

These features are measured all presence of objects and target region will be detected and tracked with help of templates.

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ii) Template Matching

An aircraft from the satellite images are detected using template matching. A sliding window over other image sequences is used to indicate the possible presence of the reference target. A regional feature matching operator is applied to find the similarity between the target model and the pixels within the window. The labelled component from segmentation module is applied to extract the region features to describe characteristics. In this paper, Correlation coefficient will be used to measure the similarity between two different objects for target identification and tracking.

iii) Correlation Measurements

This method is used to find the similarity between two different objects with their region features.Correlation Coefficient: It will be described by,

Cor_coef=[sum(sum(u1*u2))]/ [sqrt(sum(sum(u1*u1))*sum(sum(u2*u2)))]

Where, u1=F1 – mean of F1
u2= F2 – mean of F2
F1= Feature set 1
F2=Feature set 2

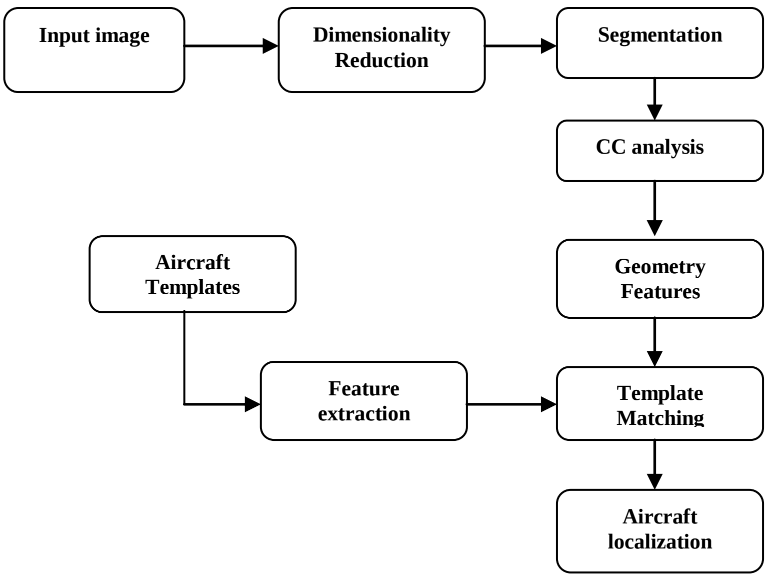

Fig. 2 Flow of Aircraft Identification

After this measurement, maximum correlated values are searched to identify the location of desired object and tracking it through rectangular box with bounding parameters.

IV. SIMULATION RESULTS

The identification and tracking system for aircraft identification based on templates. Here for experiments, the selected templates with different shape model and it is shown that are,

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Fig. 3 Templates with different shapes

From the segmented regions of input image, the local object descriptors are evaluated to characterize the shape of an object.

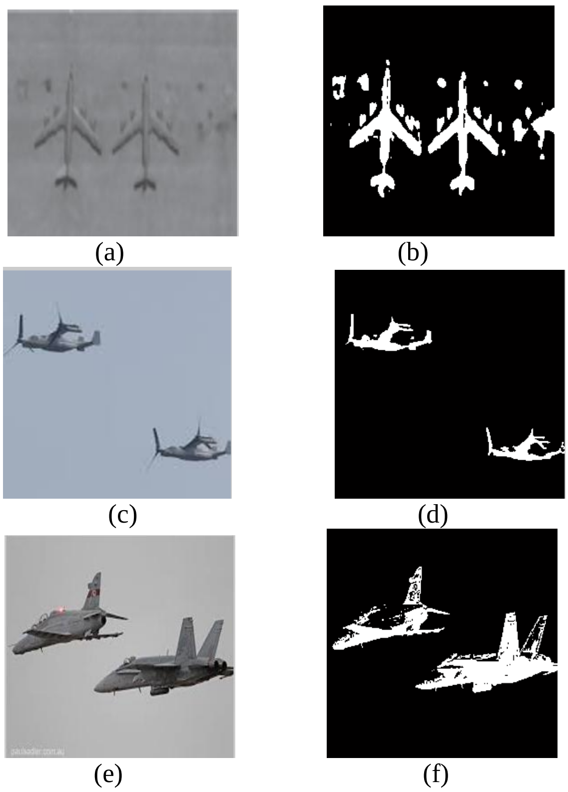

Fig. 4 Segmentation

In fig.4 (a), (c) and (e) are taken image and (b), (d) and (f) are otsu's segmented image. Each object features are matched with available templates descriptors to detect the location to track the target, the obtained results are listed as below.

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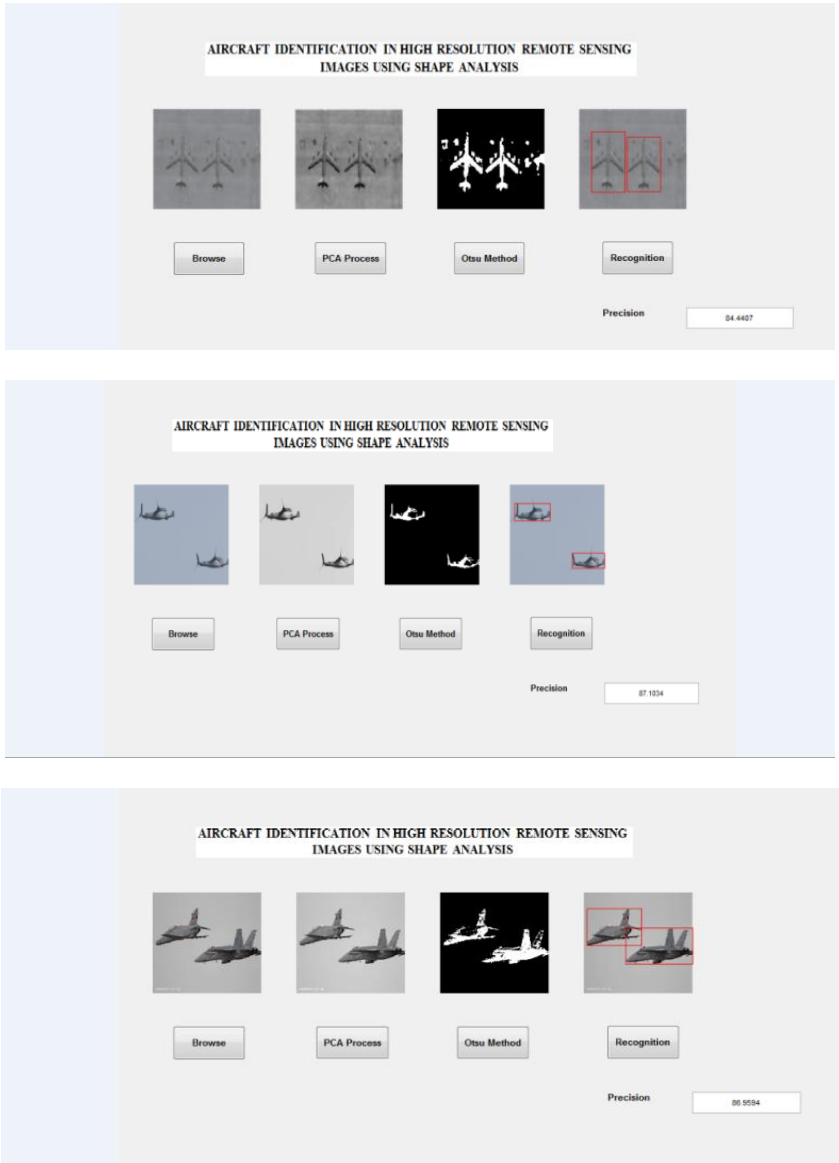

Fig. 5 Aircraft Tracking

Fig 5, shows the simulated result of aircraft identification with its precision. The tracking performance is analyzed by the calculation of precision. While we acknowledge the results shown are for a single data set with a limited number of objects the preliminary results have demonstrated the capability of tracking objects in a complex environment with the help of high resolution multispectral satellite imagery. These experiments for aircraft recognition were implemented with the help of MATLAB software and image processing toolbox.

V. CONCLUSION AND FUTURE WORK

In this letter, a new identification method for aircraft targets in high-resolution remote sensing images has been proposed. The tracking system provides the result with low computational complexity and better accuracy.

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Otsu segmentation, Template matching model and Connected component analysis was utilized effectively for enhancing a segmented regions and tracking target objects. Finally the experimental results show that our identification method yields a better efficiency with chosen techniques and methodologies. In our future work, moving object estimation will be considered. The unique algorithm will used for an optical multi - angular data set which provides the result with low computational complexity and better accuracy.

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BIOGRAPHY

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