BUILDING EXTRACTION FROM REMOTE SENSING IMAGERIES BY DATA FUSION TECHNIQUES

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Abstract

This paper presents a data fusion approach for manmade objects extraction from high-resolution IKONOS satellite images. Buildings can have various complex forms and roofs of various compositional materials. Their automatic extraction from imagery is a very difficult problem. Applying normal image processing methods could not achieve satisfied performance, especially for high-resolution satellite images. It is based on edge maps derived from IKONOS data. Local changes or variations of the intensity of the imagery (such as edges and corners) are important information for image processing and pattern recognition. K-MEANS clustering is one of the most popular techniques that can be used to classify satellite images. This technique coupled with canny edge detection, which has double threshold technique is less fooled by noise, forms a very good tool in detection of man-made features. The above mentioned techniques are applied to one meter IKONOS imagery of the highly urbanized Singapore city, to detect building edges within scene.

Keywords: *Canny edge detection, RGB color matrices, Gaussian filter, K-means clustering, non-maximum suppression.*

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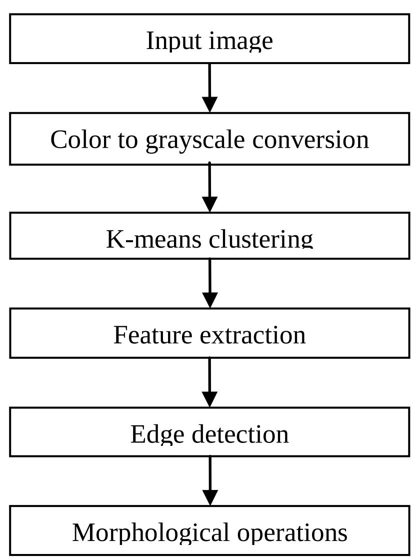
1. INTRODUCTION

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation Cartographic production facilities are involved in the creation of maps containing features such as road vegetation boundaries, and building footprints. The automation of such tasks can lead to greater productivity, resulting in reduced timelines for map production. This has significance for both military and civilian emergency purposes. With the recent advent of a series of commercialized high-resolution satellite, the potential of IKONOS imagery in topographic mapping has been investigated and highlighted by many researchers (Holland et al., 2002; Holland & Marshall, 2003).However In urban areas, it has been long a challenge topic to automatically extract urban objects from images due to the high object density and scene complexity. (Building).Buildings is the most relevant man made structures. Their detection is valuable because of the strategic human activity occurs in, are in association with, a building of some sort. In addition as they do not move, they do not serve as good references for the relative position of other type of objects. But in a highly urbanized city, detecting individual buildings is a problem, due to the proximity of the buildings to each other and the heights of the buildings which causes relief displacement. This paper deals with devolving an algorithm to rapidly and automatically extract man made features (buildings) from remote sensing imageries by data fusion techniques like k-means clustering,feature extraction,edge detection, morphological operations. The main difficulty of image segmentation is the lack of adequate tools to characterize different scales of texture effectively. Recent development in multi-resolution analysis such as feature extraction helps overcome this difficulty. This ability to discriminate features is generally dependent of scale. Another difficulty with common edge operators is that they detect too many images, which makes the map difficult to interpret. The canny edge detector uses the threshold technique by the noise is reduced and only the wanted edges are picked by settling the thresholds.

2. METHODOLOGY

The description of the approach to discriminate man-made objects from high resolution IKONOS data is shown in Figure.



2.1 K means clustering technique

Image segmentation is the process of division of the image into regions with similar attributes. K means clustering technique is performed on the collection of remotely sensed data. In our trials we have used 3 clusters. Centroids are initialized by finding the mean vector and looking for those K vectors that are farthest from the mean. Euclidean distance in the feature space is used as the measure of dissimilarity. The convergence criterion is that the difference in the centroids in successive iteration is less than a predefined threshold. At the end of this run we get a class label for each of the pixels and the centroids for each of the classes.

For the Kth cluster, the mean is given by,

$$\mu_k = \frac{1}{n_k}\sum_{i=1}^{n_k} x_i$$

Where μ k is the mean vector and n k is the number of vectors in the K th cluster.

For the K th cluster, the covariance matrix is given by,

$$C^k = \frac{1}{n_k}\sum_{i=1}^{n_k} (x_i - \mu_{k)})^2$$

Where n k is the number of vectors in the K th cluster, x i is the vector in the cluster k and μ k d is the mean vector of cluster K. Mean and covariance values are refined in the Expectation Maximization algorithm.

2.2 Texture Feature Extraction

Many land cover/land use classes in urban areas can be distinguished from each other via their shape or structure characteristics. Therefore, it is important to extract features that are able to describe relevant "texture" properties of classes.

Texture is an important characteristic for the analysis of many types of images such as an image obtained from aircraft or satellite platforms. It is the visual effect, which is produced by spatial distribution of tonal variations over relatively small areas 2 .The concept of texture can be investigated through its relationship with spectral data in fact, textural and spectral information can both be present in an image or either one can dominate the other classification accuracy.

In the proposed algorithm for classification, the co-occurrence features are selected as the basic texture feature detectors due to their good performance in many pattern recognition applications including remote sensing. A gray level co-occurrence matrix is defined as a sample of the joint probability density of the gray levels of two pixels separated by a given displacement. The features based on GLCM are energy, entropy and correlation. Gray-scale co-occurrence matrix Pd is obtained by following computation.

$$P_d = \left|(r,s),(l,v) : I(r,s) = i, I(l,v) = j\right|$$

The features computed are:

* $$Energy = \sum_i \sum_j P_d^{\,2}(i,j)$$

* $$Entropy = -\sum_i \sum_j P_d^2(i,j)\log P_d(i,j)$$

* $$Correlation = \sum_i \sum_j \frac{(i-\mu)(j-\mu)P_d(i,j)}{\sigma_x \sigma_y}$$

* $$Inertia = \sum_i \sum_j (i-j)^2 P_d(i,j)$$

* $$Inversedifference = \sum_i \sum_j \frac{P_d(i,j)}{1+(i-j)^2}$$

* $$Autocorrelation = \sum_i \sum_j ijP_d(i,j)$$

Where μ is the mean of Pd and σ y are the standard deviations of Pd (x) and Pd (y) respectively.

3. THE CANNY EDGE DETECTION

Edges of an image reflect the information of the image mostly. They contain the basis character of the image. Edges within an image correspond to intensity discontinuities that result from different surface reflectance of objects. Various illumination conditions, or varying distance and orientations of objects from a viewer. Edge detection is a common problem and of fundamental importance in image analysis and computer vision. Edges however generally occur at various resolutions, or scales, and represent transition of different degrees, or gradient levels. Perhaps the most commonly used method from detecting edges in an image is through spatial gradient. In this approach, the edges are identified by the local extrema in the differentiated image through thresholding. The canny edge detector is less likely to be "fooled" by noise and more likely to detect true weak edges, which are very important for the detection of building edges. The double thresholding of canny edge detector plays the main role in edge detection. The method uses two thresholds – to detect strong edges and weak edges, and includes the weak edges in the output only if they are connected to strong edges. The Canny operator works in a multi-stage process. The Canny edge detection algorithm has the following steps:

- Smoothens the image with a Gaussian filter.
- Computes the gradient magnitude and orientation using finite-difference approximation for the partial derivatives.
- Applies non-maxima suppression to the gradient magnitude.
- Uses the double threshold algorithm to detect and link edges.

The upper tracking threshold can be set to quite high and lower threshold quite low for good results. Setting the lower threshold too high will cause noisy edges to break up. Setting the upper threshold too low increases the number of spurious and undesirable edge fragments appearing in the output.

3.1 Morphological operations

The edge map obtained with above methodology is cleaned using morphological operators to remove stray pixels and to connect all those un-connected pixels. The various operations include, cleaning, spurring, removing, bridging, etc. The explanation for these operations is given below.

Bridge-bridge previously unconnected pixels

'Clean' - Remove isolated pixels (1's surrounded by 0's 'Close' - Perform binary closure (dilation followed by erosion)

'Diag' - Diagonal fill to eliminate 8-connectivity of Background

'Dilate' -Perform dilation using the structuring element ones (3)

'Erode' -Perform erosion using the structuring element ones(3)

'Spur' -Remove end points of lines without removing small objects completely.

Fig Caption 1: Depicts the original input image taken from ikonos

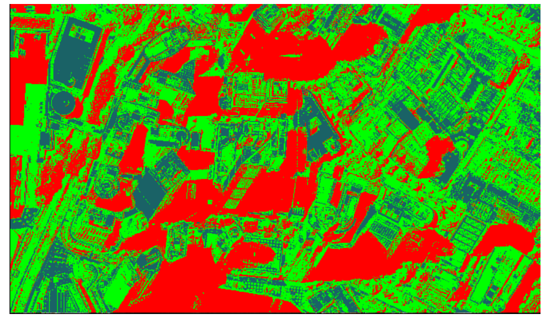


Fig Caption 2: Depicts the clustered image of the input image by k-means algorithm.

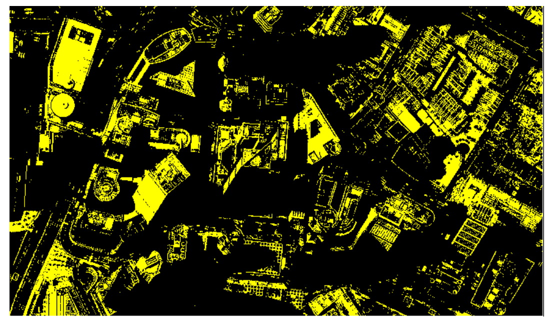


Fig Caption 3: Depicts the extraction of building features from the clustered image

Fig Caption 4: Depicts the edge detected image of Fig Caption 3 image

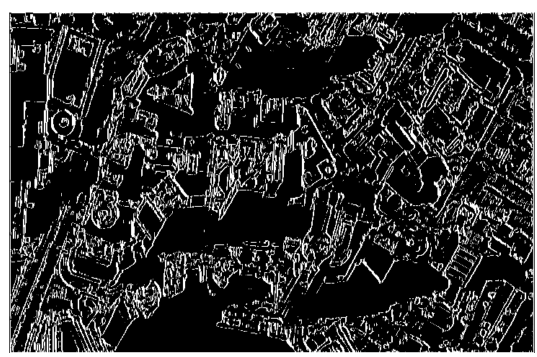


Fig Caption 5: Obtained by morphological operation to the Edge detected image from Fig Caption 4

3.2 Results and discussion

Data characteristics

This one-meter resolution color image of the city of Singapore was collected August 9, 2000 by Space Imaging's IKONOS satellite. The entire image depicts the trade and administration centers located between the mouth of the Singapore River and Canning Hill. This IKONOS imagery is used for project planning and monitoring, seaport and airport management, insurance and risk management, disaster assessment, forestry management and environmental monitoring, coastal zone mapping, urban planning, and tropical vegetation studies.

CONCLUSIONS

A new technique for the extraction of buildings from satellite images was presented. Promising results were obtained with our preliminary experiments. Further testing of the algorithm is currently under-way. It was shown that the algorithm could be extended for the detection of land cover changes from remotely sensed data. This can be used for project planning and monitoring, seaport and airport management, insurance and risk management, disaster assessment, forestry management and environmental monitoring, coastal zone mapping, urban planning, and tropical vegetation studies.

REFERENCES

[1] **Roux & McKeown, 1994] M. Roux and D. McKeown,** *"Feature Matching for Building Extraction from Multiple Views",* Proceedings, IEEE Conference on Computer Vision and Pattern Recognition, 1994, pp. 46-53.

[2] www.fp.ucalgary.ca/mhallbey/tutorial.htm

[3] **Kiwon Lee, Byung-Doo Kwon** "Urban Feature Characterization using High-Resolution Satellite Imagery: Texture Analysis Approach" **Map Asia Conference 2004 GISdevelopment.net.**

[4] N.Abbadeni, "*Computational measures corresponding to perceptual textural Features*", Proceedings of the IEEE International conference on Image Processing,pp 897-900,2000.

[5] R. L. Kettig and D. A. Landgrebe "Classification of Multispectral Image Data by Extraction and Classification of Homogeneous Objects" IEEETransactions on Geoscience Electronics, Vol. GE-14, No. 1, pp. 19-26, January 1976

[6] R.Chellappa, R.L.Kashyap & B.S.Manjunath, "*Model-Based Texture Segmentation and Classification*", Chapter 2.2 in the Handbook of *Pattern Recognition and Computer Vision*, C.H.Chen, L.F.Pau and P.S.P.Wang (eds.), World Scientific Publishing Company, pp. 277-310, 1993.