

SEMI-AUTOMATIC PROCESSING FEATURE EXTRACTION FROM AERIAL-IMAGES

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Abstract

Based on the analysis of problems in automatic interpretation of aero-imagery, a new method called operator guided semi-automatic processing for feature extraction is proposed and realized by seed based region growing and structural information aided feature extraction algorithms. Here, object oriented image feature extraction needs to be implemented in an operator guided semi-automatic processing system. Actually, it is a normal interactive image processing system. However, the most important function of this system is to combine the manual operation and the machine processing cooperatively. To verify the above mentioned strategy, a system named CV2 (Computer Vision for 2-dimensional processing) is designed.

Index Terms: Image Interpretation, Object Extraction, Operator-Machine Cooperation, Knowledge-Based Techniques

1. INTRODUCTION

Due to the high cost and several problems left in fully automatic systems, research on semi-automatic system seems to be more interesting recently. As a typical example, Gagnon proposed a microcomputer based photogrammetric system DVP (Gagnon, 1990), which combined automatic image matching with manual measuring and plotting. Research in photogrammetric landform feature measuring and plotting is also originally aimed at fully automatic image interpretation.

It is observed that the procedure of manual interpretation of image includes actually three steps, i. e., the first, affirming the existence of an object, i. e., a rectangular pattern in the image is recognized it is a building, the second, detecting the details of the object, such as the edges, corners and shadow, and the third describing the obtained objects by symbols. By manual operation, the first step normally can be implemented easily and fast and it takes much working time for the third step. However by machine processing, the most difficulty is at the first step, and the other two steps are relatively easy (Fig.1).

According to the fact mentioned above, the main consideration in this paper is to realize object oriented image feature extraction. The objects are recognized by manual operation or operator aided semi-automatic processing, then features are detected and described by computer processing. The following two measures should be taken into account:

- 1) To develop techniques for image segmentation and contour extraction with restrained conditions.
- 2) To establish an operator guided semi-automatic system.

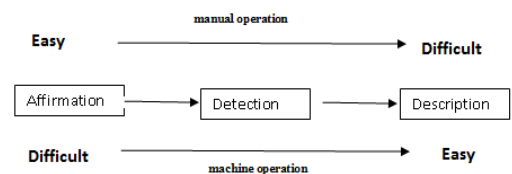


Fig-1 Image Interpretation Procedure

2. SEED-BASED REGION GROWING ALGORITHM

2.1 Difficulties in Image Segmentation

Image segmentation often meets difficulties at the ragged boundaries and non homogeneous regions, which may cause the unclosed boundaries of the regions and the non-meaning holes within the regions. In order to solve such problems, many attempts have been carried out and results differently in advantage and disadvantage (Haralick, 1985). It has been shown that the blindness in the segmentation procedure is due to be lacking knowledge during the region growing. Therefore, to develop knowledge based algorithms for image

segmentation has been in great demand. A distinguish contribute in this field has been made by Matsuyama(Matsuyama,1988). However, it is still difficult to formalize the knowledge of objects, particularly of objects in the aerial image with complex image structure.

2.2 The Strategy of Seed Based Growing

In order to resolve the contradiction between the limitations of techniques and the urgency of application, a strategy called seed based region growing is proposed. The attribute of a region is affirmed by manual interpretation, and the operator drives a floating mark into the region to plant at least one seed. Then the region growing will be performed automatically. Because of the combination of manual operation and automatic processing in feature recognition detection and description, the efficiency and reliability can be better than that in either manual or machine operation

2.3 Algorithm and experiments

For realizing the strategy a seed based region algorithm is designed and the experiments with real data are performed.

2.3.1 Growing Way

Starting from the seed, region is growing along the way in spread manner which is effective in accordance with the consideration of processing speed and memory space. The technique of exchanging indicating signs marked on contour of region boundary is implemented to reduce the memory space occupied by algorithm.

2.3.2 Criterion of Growing

Assuming the grown region has N pixels with mean gray X' and dispersion S:

$$S = \sum_{i=1}^N (X_i - X')^2$$

The T statistic can be constructed

$$T = (y - X') \sqrt{(N-1)N / (N+1)S^2}$$

here y is the gray value of the present pixel P.

The criterion is as

$$P \in W1 \quad \text{if } T > T_{\alpha/2}$$

$$P \in W2 \quad \text{if } T \leq T_{\alpha/2}$$

Here, the W1 and W2 indicate the pixel inside and outside of the region respectively. $T_{\alpha/2}$ is a statistic threshold value which is determined by the significance level α , normally, α can be taken very small (0.001-0.0001).

2.3.3 Description of the Region Boundary

The region boundary is described by chain codes. The steps of the procedure are as following:

(1) Record chain codes along the boundary according to the rule shown in Tab 1

Direction	0	45	90	135	180	225	270	315
Codes	0	1	2	3	4	5	6	7

Tab 1: Chain codes

(2) Calculating the curvature at each chain point:

$$a = \left[\sum_{k=i}^{i+n-1} \cos\theta(k) - \sum_{k=i-n}^{i-1} \cos\theta(k) \right]$$

$$b = \left[\sum_{k=i}^{i+n-1} \sin\theta(k) - \sum_{k=i-n}^{i-1} \sin\theta(k) \right]$$

$$\text{CUR}(i) = \arctan(a/b)$$

Here CUR (i) is the curvature at point i, $\theta(k)$ is the chain direction at point k, the point number k is within a range 2n as shown in Fig. 3.

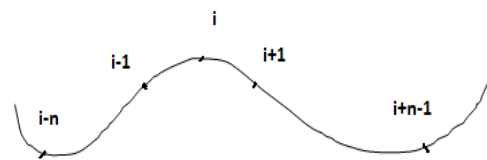


Fig-2. Curvature

(3) Data compression and contour modification.

Data compression can be performed by restoring the key points with extreme values of curvature. According to the curvatures variation, the contour of the region can be modified, for example, a small concave corner which is indicated by a minimum value of curvature can be detected and replaced by a straight line. It can also be modified by operator guided processing and object models.

3. GEOMETRIC CONDITION RESTRAINED

IMAGE FEATURE EXTRACTION

Under the strategy of operator guided processing, the structural knowledge about objects in the gray scale images are described by geometric conditions, which can be used to aid the feature extraction.

3.1 Model Driven Hough Transformation

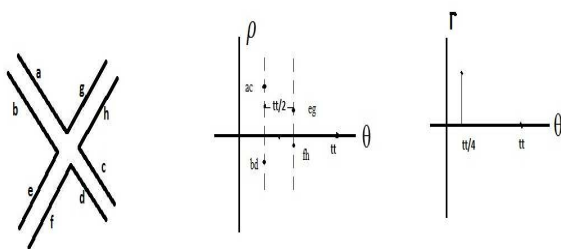
3.1.1 The problems in normal procedure

It is observed in practice that there are some problems in the normal procedure of Hough transformation:

- 1) It can only determine the parameters of line, but not determine the start and the end points of the line.
- 2) Due to effect of noise, the point with extreme value in Hough space is not detected easily.
- 3) False points or false lines may be extracted in some cases.

3.1.2 Model Derived Hough transformation

Fig.4b shows the Hough space with parameter ρ and θ .



a) feature (b) Hough space (c) θ space
Fig-3. Model driven Hough transformation

As an example, the features of Fig. 4(a) correspond to 4 points in Fig. 4(b). The corresponding relation can be formed as a θ function shown in Fig. 4(c). It is more easy to detect parameter θ of lines in θ space than that of the 4 single line in Hough space. Furthermore, the line parameters of 4 lines can be determined by the known object models.

3.2 Building Contour Extraction

3.2.1 Automatic Extraction

Automatic processing can only be carried out at the condition of good image quality and the given window in which the existence of building is confirmed. The procedure can be briefly present as following:

- (1) Edges region focusing with directional masks.

- (2) Straight lines detection using heuristic technique.
- (3) Straight lines description with parameters, such as direction, length, difference between the two side gray values etc.
- (4) Corner formation based on right angle or other given knowledge of buildings.
- (5) Building verification by the conditions of contour shape, homogenous of the region and the properties of edges.
- (6) Representation of the detected building contour with the parameters of centre point (x, y) direction, width, length and the mean gray value etc.

3.2.2 Model Guided Building Extraction

As many buildings have similar shapes in the images, the method called model guided building extraction is proposed to extracting the other buildings with the similar shape as one that has been previously extracted and described. The method is implemented by the following two ways:

- (1) Parameter controlled detection.

As shown in Fig; 5, the image of building C has partly been occluded by trees, but it can be detected by using the building parameter sets of building A and B which has been established previously.

- (2) Contour template matching.

The building B can be extracted by contour matching method in which the template of A can be selected from the building representation data base.

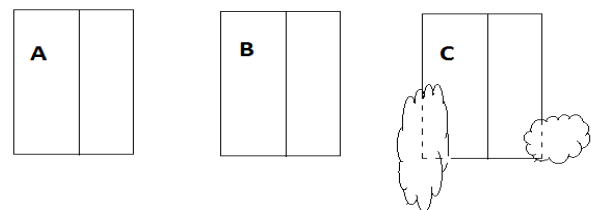


Fig-4. Model guided extraction

4. OPERATOR / MACHINE COOPERATION

As mentioned above, object oriented image feature extraction needs to be implemented in an operator guided semi-automatic processing system. Actually, it is a normal interactive image processing system. However, the most important function of this system is to combine the manual operation and the machine processing cooperatively. The following techniques are taken for operator-machine cooperative operation.

- (1) When operator recognizes an object from the image and input the attribute code of the object, the object parameters for further processing will be automatic determined by searching from established data base.

(2) If precise location of a point is necessary, the operator is only required to drive a floating mark to the approximate location. The algorithm has snap function.

(3) When automatic processing has been in blind situation, the operator can make corrections in good time or in post processing procedure.

5. EXPERIMENTS

To verify the above mentioned strategy, a system named CV2 (Computer Vision for 2-dimensional processing) is designed. The components of CV2 are shown as Fig. 6. Two sets of aero photographs of urban areas with scale of 1: 2000 and 1: 10000 have been processed Fig-7. About 75% features, i. e. buildings, lakes, etc. are processed semi-automatically, and the other features, most of them are occluded by some another objects, are processed by manual driven floating mark according to the observing the visual image on the screen.

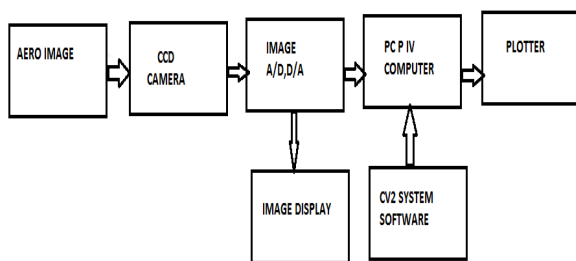


Fig.6.The CV2 System



Fig-7 .Extraction of Buildings

6. CONCLUSION

It is obviously from this research that the knowledge of objects can be used to make object oriented image feature extraction, and based on this techniques, the development of operator guided semi-automatic system for fast processing of aerophotogrammetric data is possible and useful.

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BIOGRAPHIES



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