A PROPOSED MODEL FOR SEGMENTATION OF SPOT IMAGES

Jalal amini

Department of Surveying Engineering, Faculty of engineering, University of Tehran, Tehran, Iran.
jamini@ut.ac.ir

KEY WORDS: Photogrammetry, Automation, Extraction, Fuzzy, Image

ABSTRACT:

Images are the most important data sources that used for problems in photogrammetry such as automatic object extraction, automatic orientation and so on. In the most problems, it needs to segment an image to unknown regions for further analysis. In this paper applied a model for segmentation of an image. The model is applied base on smoothed histogram of the image. First, the histogram of the image is smoothed with gaussian kernel and then, the regions with similar properties are detected based on the automatic extraction of peak and valley points in the smoothed histogram to segmentation of image. In the model, we consider the common areas between the objects as fuzzy areas. The model is tested on the Spot images from Iran.

1. INTRODUCTION

Automatic information extraction of the terrain surface in the fields of photogrammetry and remote sensing requires the formulation of procedures and knowledge that encapsulate the content of the images. This is a non-trivial task, because of the complexity of the information contained in the images. Images of the terrain surface in photogrammetry may have scales varying from 1:3000 to a smaller scale of 1:90000 while in remote sensing the pixel footprints usually vary from 1 to 30m (Sowmya and Trinder, 2000). The structure of the features in images of the terrain is complex, being a combination of many different intensities that can represent natural features, man made objects such as buildings and roads , shadows and other changes in brightness. In addition , when the scale increased, the content in which features occur becomes considerably more complex. These characteristics mean that extraction of information in aerial and satellite images presents major challenges.

In order to use automatic mapping or special data acquisition and updating, identification of cartographic objects in aerial/satellite images has attracted increasing attention in recent years in digital photogrammetry and remote sensing. Extraction of roads as man-made objects are attended in automatic mapping. Therefore, road detection is necessary for the automation of extracting roads from images. In recent years a number of papers are published in road extraction (Baumgartner et al., 1999; Barzohar and Cooper, 1993; Couloigner and Ranchin, 2000; Gruen, 1997). Some papers applied semi-automatic methods and others used automatic methods. When we use automatic methods, it is necessary to make clear roads from images.

The high capability of high resolution satellite imagery (HRSI), that includes spatial, spectral, temporal, radiometric resolution and stereoscopic capability is a powerful new source for the photogrammetry and remote sensing. Therefore there is a wide desire to extracting accurate 2D and 3D terrain information from 1m satellite imagery. Also, there are four advantages of high resolution satellites (Li, 1998). First, the highest resolution ever available to the civilian mapping community. Second, extremely long camera focal length for capturing terrain relief information from satellite orbit. Then, for-nadir and aft-looking linear CCD arrays supplying in-track stereo strips and " pointing " capabilities generation cross-track stereo strips. Finally, a base-height ratio of 0.6 and greater.

In this paper, we use a method based of fuzzy sets for segmentation of Spot images.

2. FUZZY MODEL

Recently, fuzzy set theory has been widely used in photogrammetry and remote sensing. Researchers like Wang (1989) applied fuzzy set theory in an expert system for remote sensing image analysis, Moon (1991) used fuzzy logic system for integration of different data sets and Krishna Mohan et al. (2000) used fuzzy logic approaches for land use classification on IRS-1A L2 data. Here, we used fuzzy logic system for road identification from IKONOS images.

The complete structure of a fuzzy logic system for segmentation consist of three steps: First, all input, real variables (Means and SDs), have to be translated into linguistic variables, Mean and SD, (fuzzification step). Second step called fuzzy inference that evaluates the set of IF-THEN rules that define system behavior. The last step called defuzzification that translates the fuzzy inference results into a real values as output. Here, we used three linguistic variables with their terms as follows:

Mean = {Down-bad, Down-prob-good, Good, Up-prob-good, Up-bad},

Standard-Deviation(SD) = {Down-bad, Down-prob-good, Good, Up-prob-good, Up-bad}, and

Gray-Scale(GS) = {Down-bad, Down-prob-road, Road, Up-prob-road, Up-bad}.

Two membership functions: Π_shape and Gaussian_shape, are used for all the variables terms. We defined vector X as input linguistic variables ,(Mean and SD), and Y which include the output state linguistic variable, Gray-Scale,. For every linguistic variable, each term is defined by its membership function $\mu_{(x_i)} = \{\mu^1_{x_i}, \dots, \mu^k_{x_i}\}$ and $\mu_{(y_j)} = \{\mu^1_{y_i}, \dots, \mu^k_{y_i}\}$; k=1,...,5.

In the fuzzy inference identify the rules that apply to the current situation and compute the values of the output linguistic variable. The computation of the fuzzy inference consists of two components:

1) Computation of the IF part of the rules, and 2) Computation of the THEN part of the rules. For example:

IF Mean == Good AND SD == Good THEN Gray-Scale = Road

At the end of the fuzzy inference, the result is the value of a linguistic variable. To use it to the crisp value, it has to be translated into a real value (Defuzzification). The relation between linguistic values and corresponding real values is always given by the membership function definitions. In this paper, the center of maximum (COM) is used for defuzzification. Let w_j be the most typical values of the terms with membership function, $\mu^j_y(w)$, then the defuzzification output is:

$$y = \frac{\sum_j \mu^j_y(w_j) w_j}{\sum_j \mu^j_y(w_j)} \qquad (1)$$

3. IMPLEMENTATION AND RESULTS

The study area constitutes Spot image from an area of Iran in multispectral mode (Fig 1).

FIG. 1. The spot image for study area.

In last section, we used Mean and SD as linguistic variables and Π_shape and Gaussian_shape as membership functions for segmentation in Fig. 1. Fig. 2 shows the membership functions for input and output linguistic variables.

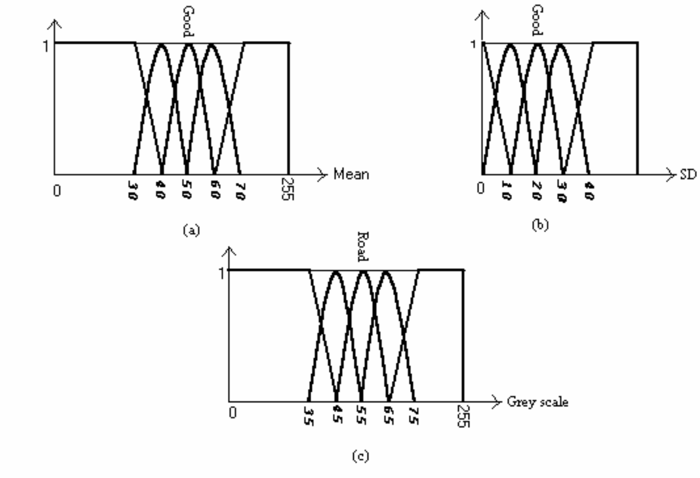

FIG. 2. The membership functions for the linguistic variables: (a) Mean; (b) Standard_Deviation; (c) Gray_Scale.

The values of Mean and SD before fuzification are determined in two steps from histogram of the image.

Step 1: Histogram smoothing; Looking at histogram, scatterplot of the data may indicate that the data are not well fit by any of the standard types of distributions. In this case, nonparametric techniques are needed for fitting an arbitrary density to a set of samples.

One of the ways of obtaining an approximate density function from sampled data is kernel method. Here, we used Gaussian density function as kernel function which produce the estimated density function for data. Choosing good width and SD for kernel function is a problem. If the width is too large, fine structure will be lost, but if the width is too small, the resulting approximation will not be sufficiently smooth. In this study, the optimum width and SD of the kernel function is determined 3 and 0.4 respectively.

Step 2: Objects detection. After the histogram is smoothed from the last step, the objects, the regions with similar properties, should be detected from the smoothed histogram. That is done by detection of the peak and valley points. The following rules are applied to define the peak and valley points of the histogram.

i). The first derivative indicates peak and valley points of the histogram when the mask -1 1 is convolved with the smoothed histogram (points *a*, b, c and d in Fig. 3).

ii). The mask -1 1 is convolved again on result *i)* to indicates the second derivative. If the second derivative will be greater than zero and the first derivative equal to zero then, the point is valley. If the second derivative will be less than zero and the first derivative equal to zero then, the point is peak.

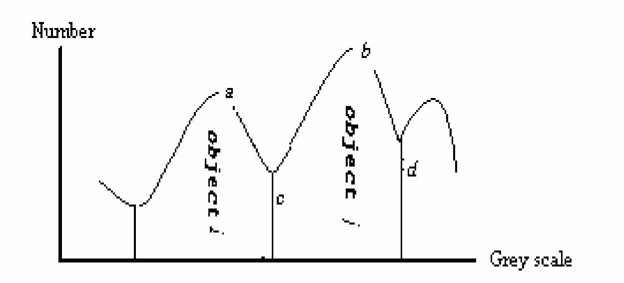

FIG. 3. The peak and valley points of histogram.

Therefor, the peak and valley points are detected by using these rules. Each peak point and two neighboring points, the left and right valley points of the peak point, corresponds an object (objects *i*, and *j* in Fig. 3). The Mean and SD of each object are calculated and used as the values of real variables.

FIG. 4. The segmented image.

Mean and SD of each object are determined and used as input into the fuzzy mode. Fig. 4 shows the result of the segmentation.

CONCLUSIONS

In this study, we used fuzzy logic system for segmentation of spot images. The results showed that if the range of SD and mean of gray levels were varied from 36-38 and 226-228 for objects such as roads and 38-40 and 20-190 for non-roads respectively. Then, the optimum width and SD of Gaussian kernel function would be 3 and 0.4 respectively. The skeleton of segmented image could be extracted by mathematical morphology and vectorized to put directly in to GIS. At the end, this approach can be proposed in large scale imagemap for segmentation.

ACKNOWLEDGMENT

The author would like to thank Faculty of engineering, University of Tehran for supporting this project.

REFERENCES

AMINI, J. and SARADJIAN M.R., 2000. Imagemap simplification by using mathematical morphology. International Archives of Photogrammetry and Remote Sensing, xxxiii(B3): 36-47.

BARZOHAR, M. and COOPER, D.B., 1993. Automatic finding of main roads in aerial images by using geometric-stochastic models and estimation. Proceeding of the IEEE Computer Vision and Pattern Recognition, July 1993, 459-464.

BAUMGARTNER, A., STEGER, C., MAYER, H., ECKSTEIN, W. and EBNER, H., 1999. Automatic road extraction based on multi scale grouping and content. Photogrammetric Engineering & Remote Sensing, 65(7): 777-785.

COULOIGNER, I. and RONCHIN, T., 2000. A multiresolution modeling approach for semi-automatic extraction of streets. Photogrammetric Engineering & Remote Sensing, 66(7): 867-874.

GERLACH, F., 2000. Characteristics of Space Imaging one_meter Resolution Satellite imagery Products. International Archives of Photogrammetry and Remote Sensing, xxxiii(B1).

GRUEN, A. and LI, H., 1997. Semiautomatic Linear Feature Extraction by Dynamic Programming and LSB_Snakes. Photogrammetric Engineering & Remote Sensing, 63(8): 985-995.

KRISHNA, M., BABA MADHAVAN, B. and DAS GUPTA, U.M., 2000. Integration IRS-1A L2 data by fuzzy logic approaches for landuse classification. International journal of remote sensing, 21(8): 1709-1723.

LI, R., 1998. Potential of high resolution satellite imagery for national mapping products, Photogrammetric Engineering & Remote Sensing, 64(12): 1165-1170.

MOON, W. M. and AN, P., 1991. Integration of geophysical, geological and remote sensing data using fuzzy set theory. Geoinformatic, 2: 171-176.

SOWMYA, A. and TRINDER, J., 2000. Modeling and representation issues in automated feature extraction from aerial and satellite images, ISPRS journal of photogrammetry and remote sensing, 55(1): 34-47.

WANG, F., 1989. A fuzzy expert system for remote sensing image analysis. Proceedings of IEEE Geoscience and Remote Sensing, 848-851.