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Joji Iisaka

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TEXTURE ANALYSIS BY SPACE FILTER AND APPLICATION TO FORESTTYPE CLASSIFICATION

JOJI IISAKA
Tokyo Scientific Center, IBM Japan, Ltd.

1. INTRODUCTION

This paper describes a new method for defining textural properties of images by applying various types of space filters which have the same functions as "field stop" of an optical filter.

Spatial environments can be understood as being spatial distributions of various area-extensive objects with characteristics such as size and reflectance or emissive qualities. The spatial organization and relationships of the area-extensive objects appear as spatial distributions of grey tone imagery taken of the environment.

There have been seven basic approaches to the measurement and quantification of image texture.

The author introduced a method to describe textural properties and the method was applied to a problem of classifying forests.

2. SPACE FILTERING

The basic idea of a space filter is as follows:

Let S(i,j) be as the value of picture element (i,j).

Applying filter function F, response S'(i,j) is:

$$S'(i,j) = F + S(i,j)$$

Here, we introduce reticle type mask as Fig. 4 (a), (b).

Let F be as a K x K matrix and the matrix elements, Fem = 1, or 0 according to the mask type.

Using various types of masks, we obtain various response values for picture elements (i,j). A number of response values can be generated as additional channel data besides spectral channels.

The above filtering techniques are kind of space filtering. This filtering is equivalent to the system where a reticle is put on the field stop surfaces. Image of an object is located in a space coordinate. (x,y) are generated through the object lens on the image plane. The light energy is collected by a condenser lens and the total energy is measured by a sensor.

Let the input message spectrum be as G(fx,fy), and R(fs,fy) be as a transfer function at the field stop. The output message spectrum U(fx,fy) is

$$U(fx,fu) = K\ R^*(fs,fu)\quad G(fx,fy)$$

The transfer function can be set arbitrarily by selecting a mask pattern on the field stop.

The message signal from an object is maximized when an optimal filter and a power spectrum density of a background scene are known.

Thus, an attempt was made to simulate the system by using several types of mask patterns.

As the reticle itself has an effect of a spatial low pass filter, spatial resolution is degraded.

3. APPLICATION OF TEXTURE ANALYSIS FOR FORESTS

For protection and management of the forest resources, it is important to get timely and accurate information of the global geographical distribution of plants in forests. But it will take much time and labor work to obtain such information only by field work. Therefore, we

presently need to utilize remote sensing techniques, especially image analysis techniques to get the information of forest environmental changes.

In this study, we tried to draw a forest classification map using digital image analysis techniques, and compare the results with ground truth data taken in the form of air-craft photographs. Then, we consider the potentiality of texture analysis techniques.

As an approach to image analysis of forest resources, spectral data classification is well known. And also, the method has proved to be useful. It is possible to classify each tree species using spectral data, but this information is not effective for such local properties of a forest as arrangement, sparsity and density of trees. So, we introduced texture analysis techniques for forest analysis, and examined the feasibilities of these techniques, comparing them with spectral classification techniques. This texture analysis method was applied to aircraft MSS DATA of OTOINEPPU, a northern part of HOKKAIDO. Then, we used two different ways for texture classification one of which is the space filter method, and another is NARALICK'S METHOD.

The forest can be classified into several categories such as needle-leaf, broad-leaf, and mixture, etc., and each group into two categories-thin wood and thick forest.

These pictures show that we could get fine classification and good correspondence to ground truth by using space filter process.

The performance of the classification methods shows the overwhelming usefulness of space filter process. According to these results, we can say that texture analysis based on spatial information is superior to the past spectral classification method, and as one of these texture analysis methods, filter process has a potentiality for analysis of forest resources and of other fields, e.g., the classification of a city area.

4. CONCLUSION & REMARKS

In summary, application of textural analysis method to a forest area yields these results.

1) Space filter is useful for extracting local feature of ground covering objects as well as spectral characteristics.

2) There is an optimal window size of a filter and a filter type for each class to be classified.

3) It is possible to classify the forest into two groups, thick and sparse tree by textural features.

4) In the case of classification into three groups, needle-leaf, broad leaved and mixed tree, the boundaries among them change continuously. If the ratio of constitution of composite tree is defined clearly, it will be possible to classify forestry more correctly by space filter method.

JOJI IISAKA

B.S. and M.S. on Physics, St. Paul University.

Working at Tokyo Scientific Center as a project leader on digital image processing, and advising students from universities.

The main research area is remote sensing of environment and resource management.

The major concerns are; 1) Image Processing system development, 2) Textural analysis and 3) Marine environment, urban environment and agricultural analysis.