Chapter XI

Optimizing Texture
Primitive Description,
Analysis, Segmentation,
and Classification Using
Variography

Assia Kourgli, U.S.T.H.B. University, Algeria
Aichouche Belhadj-Aissa, U.S.T.H.B. University, Algeria

ABSTRACT

There are many approaches dealing with various aspects of texture analysis, segmentation and classification. One of the characteristics among most of these approaches and those using neighborhood is that they require applying a template to a given image, pixel by pixel, to yield a new image. Although the selection of an appropriate window size is critical and affects directly the results obtained, it is often done arbitrarily. We present, in this chapter, a new approach based on the concept of variography to achieve the selection of the optimal window. We develop some direct applications including textural primitives description, mathematical morphology, textural segmentation and textural classification. Promising results are obtained and presented.

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INTRODUCTION

Texture plays an important role in visual information processing since it provides useful information about shape, orientation and depth of the objects. To develop a texture analysis system capable of dealing with all aspects of texture structure is a very difficult visual information processing task because of the complex nature of texture, and is, as yet, an unsolved problem. It is important to use properties of texture and to understand how the human visual system works for texture discrimination and grouping necessary to the analysis.

There are many approaches dealing with various aspects of texture analysis, segmentation and classification (Reed, 1993; Sharma, 2001; Tuceyran, 1998). One of the characteristics among most of these approaches and those using neighborhood is that they require applying a template to a given image, pixel by pixel, to yield a new image. Successful textural analysis relies on the careful selection of adapted window size because it determines the amount of information that has to be evaluated. On one hand, window size should be large enough to provide as many details as possible about texture pattern and, on the other hand, be small enough to take only the relevant information. So, the selection of an appropriate window size is critical because it affects directly the results obtained.

Our purpose in this chapter is to achieve the selection of the optimal window using a concept belonging to geostatistics (Cressie, 1993). Indeed, geostatistics is the analysis of spatially continuous data. It treats geographic attributes as mathematical variables depending on their locations. One of the central techniques among geostatistical approaches is the variogram, which describes to what extent spatial dependence exists between sample locations. We show that the variogram measure provides a description of the placement rules and the unit patterns of texture. Indeed, local minima of the variogram measure can be used to describe size, shape, orientation and placement rules of unit patterns of a texture (Kourgli, 2000). Using hole-effects, we can determine the size and shape of the optimum window and obtain a description of texture primitives. The second application is mathematical morphology, where we apply variography to find the optimal structuring element applied with morphological operators. The results obtained are evaluated using a contour enhancement algorithm. The others applications are textural segmentation and textural classification. We propose to use some further features extracted from the variogram representation (range of influence, variogram values, etc.) in a segmentation scheme. The segmentation and classification processes are performed on Brodatz’ textures (Brodatz, 1966) to be validated. Then, they are performed on photographic urban images for the identification of built-up environment and cover lands. Promising results are obtained and presented.

In section 1, we review research in the area of texture analysis, texture segmentation and classification. One of the key aims of literature review is to learn of what other research has taken place in finding the optimal window size for texture description. In section 2, we provide a detailed methodology of how we aim to apply variography to texture analysis. In section 3, we describe the processes used for texture primitives detection, mathematical morphology, texture segmentation and classification. Some algorithms are presented to show in more detail the processes that are applied to images before final results are obtained. These algorithms can be easily programmed, with some additional reading, using C++. We also show the results of detailed experiments with...