Gabor Filter Applied in Supervised Classification of Remote Sensing Images

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Abstract

This poster describes a technique of classification of remote sensing images using the texture attribute as source of data. The processes of classification/ segmentation are described and the use of Gabor Filters for the supervised classification of such images is proposed here, for the purpose of separating areas of water, vegetation and urban region. The properties of the Fourier spectrum were used in the recognition of the most representative frequencies of each area to separate the classes. The classification of the images was done with the software tools MultiSpec and PRTools.

1. Introduction

Remote Sensing is an applied science area, related to acquisition of information about the surface of the Earth. In the process of analysis and extraction, classification/segmentation algorithms may be used, which divide an image into regions corresponding to the areas of interest. A region can be defined as a contiguous ensemble of pixels with two-dimensional spreading, which represents uniformity regarding a determined attribute, such as texture, for example [1]. Texture is one of the most important characteristics to classify and recognize objects and scenes, and can be characterized by local variations in pixel values that repeat in a regular or random way across an object or image [3].

The three main approaches used in classification of images for a texture description are the statistical, structural and spectral. The spectral approach is based on properties of the Fourier spectrum, being used basically in detection of global periodicity in an image through identification of peaks of high energy in the spectrum [3]. In this work, a Fourier Transform was applied to an entire image to analyze the resulting components, considering that it tends to localize information about patterns previously globalized in the image.

The sorters based in characteristics of texture, contains informations about the spatial distribution of the object shading variations. The classifications algorithms analyses individually the numeric attributes of each pixel in the image, marking thus a quantitative approach with the intention of to find the boundaries to decision between the classes (water, vegetation, e.g.).

During the process of supervised classification, the user indicates representative samples to each class that must be identified in the image. Using statistical functions and parameters, the algorithm defines which class each pixel belongs.

The image segmentation is a clustering data technique, which only the spatially adjacent regions can be cluster. For accomplish the segmentation is necessary define the similarity and area thresholds [2].

The visual interpretation, the segmentation and the classification are important and complementary methods, that frequently are used of combined manner aim at get the best results in the task of information extraction in the images [1].

2. Methodology

Textural characteristics of different regions of an image were extracted by selective filtering. Among various alternatives, the utilization of Gabor filters [3] may be highly efficient in the process of texture analysis by spatial frequencies.

In his earlier work, Gabor [3], [4], demonstrated the possibility of characterizing a signal simultaneously in the temporal and frequency domains, that are limited by relation of uncertainly conjunct.

Essentially, the function reported by Gabor describes a sinusoidal wave with modulate frequencies

by a Gaussian envelope. The filters ensemble original proposed by Gabor extended to the two-dimensional case by Daugman [4] may also be applied to data of image type and is represented by the function:

$$f(x, y, u_0, v_0, \sigma_x, \sigma_y) = \frac{1}{2\pi\sigma_x\sigma_y}$$

$$\exp\left\{-\frac{1}{2}\left[\left(\frac{x}{\sigma_x}\right)^2 + \left(\frac{y}{\sigma_y}\right)^2\right]\right\}\exp\{2\pi i(u_0 + v_0)\}$$

The filter extension varies inversely in the spacial and frequencies domains. Filters with small extension in the spacial domain allows better conditions in the classification process, inasmuch a smaller band in the frequencies domain allows a better discrimination between different textures. These considerations evidence an advantage presented by Gabor filter that has an optimum resolution conjunct in both domains.

However, in order that, the filter may capture correctly the frequency desired in the spacial domain, the filter dimensions (dim) must includes at least a complete range of the frequency. The spacial extension – σ – of the filter should be obtained from the dimension (dim). Ideally, the spacial extension should be one such as the filter will include nearly an area equal the dim value. For a Gaussian function includes 99,73% of the area defined by dim, σ to be equal to:

$$\sigma = \frac{\dim}{6}$$

The approach adopted consist in the following stages: selection of representative areas in each class; identification of most representative spatial frequencies in each class; selection of the most appropriate frequencies to separate the classes; construction of Gabor filters appropriate to each select frequency; convolution of each filter with the image, creating a same number of filtered images, that could be called "textural bands"; classification of the image using this "textural bands" and analysis of the performance of the methodology proposed.

3. Experiments

Using images obtained of the LandSat satellite and utilizing the MATLAB 7.0 software for Windows, were selected representative samples of each class: water, vegetation and urban region, with the purpose of know the most representative frequencies in each one of the classes.

Can note in the analyzed images that the water is characterized by low frequencies, whereas the medium frequencies represents the vegetation and the high frequencies represents the urban region. In this moment there was the necessary of Gabor filter implementation, but it was not possible in this first moment, so we choose use softwares that do the classification of images: MultSpec and PRTools, which allowed us a fast and detailed analysis of the images.

4. Conclusions

It is proposed here to apply a method of supervised classification to digital images, using the texture attribute. The methodology proposed, consists in characterizing textural classes present in the image by the most representative spatial frequencies identified in the samples of each class.

The development of routines to analyze the images using MATLAB 7.0, proved to be a prolonged process, justifying the use of MultSpec and PRTools to obtain preliminary results. It was noted that there is a huge difficulty in the separation of the frequencies that uniquely represent each class, as depending on the texture roughness, the classes interlink. Taking into account, that variations as scale, satellite and different regions interferes in the performance of the method. In this way, testes and deepened studies have been doing, to obtain better results.

5. References

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