A STUDY OF CLASSIFICATION TECHNIQUES APPLIED TO CBERS SATELLITE IMAGES

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Abstract: In this paper its presented classification methods for identify forests with araucaria angustifolia, using artificial intelligence and Fractal approach. Studies were made to perform experiments in which could be verified the suitable of ANNs for classification of CBERS satellite images. However, it was noticed in that classification a significant error exists. Then, it intends to continuity that study through the incorporation of new techniques of treatment of the images before the submission to Neural Networks training with the use of error minimization techniques. When applying the detection of borders in those images, it was noticed that those limits possesses, visibly, patterns that could be good as additional information for identification of a class. Therefore, it is supposed that those differences can be quantified by Fractal Dimension calculation, whose definition is going of encounter with the need of establishing patterns for those borders or limits. Fractal Dimension study verifies the adaptation of that technique to determine areas that the Neural Networks and the method Maximum Likelihood doesn't get to distinguish.

1 INTRODUCTION

The satellite image information can be extracted through classification of these images. There are various classification methods that try through several approaches to identify with accuracy the information of each image pixel, classifying them in categories or classes according to their spectral information. Image classification methods can have different accuracy levels, according their approach and parameters specification. Some of pixel classification methods that are more used by Geographic Information System (GIS) are based in statistical inference. In this context it's checked if the Artificial Intelligence based technique is suitable for image classification (W. Gonzalez, 2000) (Haykin, 1999) (Feder, 2000). In this paper it's presented in its first section a comparative study between two satellite image classification techniques: the Statistical Method of Maximum Likelihood (ML) and an Artificial Intelligence technique, based on the learning of Artificial Neural Networks (ANNs).Due to confusion that both methods obtained in some regions, it is proposed in this article the development of an approach that involves information of image areas (sets of pixels) instead of pixel-to-pixel information. In this paper it is showed that he Fractal Dimension concept can be applied to supply the need of to accomplish the identification of the classes in that the studied methods didn't get to identify with accuracy. In section 3, its presented the initial experiments made in CBERS 2 images, where fractal dimension will be used to distinguish two interest class.

2 MAXIMUM LIKELIHOOD vs. ARTIFICIAL NEURAL NETWORKS

In order to classify an image of the CBERS-1 satellite were used the Maximum Likelihood method and a method based in the training of Artificial Neural Networks, whose detailed description can be seen in other works.

In the experiments accomplished with those classifiers, it was observed a high rate of success of both methods for the classes water and forest (the classes identified were: water, forest, no-forest and Deforestation).The Kappa coefficient calculated (0,65 for MAXVER and 0,64 for the RNAS) is considered sub-

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stantial for both methods. The classifier based in Neural Networks presented satisfactory results, compared with the Maximum Likelihood. This indicates that this method demonstrated that it is suitable for the classification of satellite images. However it is observed that both methods tend to confuse the areas of the deforestation class with the no-forest class. It is believed that that confusion happen because the grayscale values of the píxeis of those two classes are very close. For that reason it was started the study of Fractals as a Minimization Error Technique.

2.1 Study of the Minimization Error Technique

Through the study and of the accomplished experiments it was verified that the classification neural is suitable for the images of the satellite CBERS. However, this classification still has a significant error. It is intended to give continuity to this study through the incorporation of new techniques of treatment of the images before the submission to Neural Networks training and of techniques for Minimization of Error. One of these techniques intend to decrease the error of the classification that happens in the borders, or transition limits between a class and another. It is observed in the images that some classes present very defined limits and with different characteristics. If it is applied border detection in these images is noticed that those limits have visibly patterns or irregularities that could be used as additional information for identification of a class. It is supposed that those differences can be quantified by Fractal Dimension calculus (Feder, 2000), whose definition supplies the need of establishing patterns for those borders or limits.

Fractal Dimension study verifies the adaptation of that technique to determine areas that the ANNs and the method ML doesn't get to distinguish.

2.2 Fractal Dimension

Fractal objects are not measured by length or area. They are "more" than lines and "less" than a plane. To measure them, it is used the concept of Fractal Dimension. Fractal Dimension is a measure that quantifies the fractal density in the metric space it is defined, being used for compare it. (Feder, 2000) (Conci, 2004) .

2.3 Fractal Dimension Calculus

In geometric objects (with dimension 1, 2 or 3) it is used a simple relation among dimension, number of blocks that is necessary to recover them and the size of the blocks. It is expressed such as:

$$d = \frac{\log N}{\log (1/L)}$$

where N is the number of blocks with side L of que recovering and d is the dimension. In a log-log graph, this relation is translated as a line. The line's slope is the Fractal Dimension d (Feder, 2000) (07, 2004).

2.4 Methodology

For the calculus of the Fractal Dimension of each class, it was developed an algorithm that obtains the approximate values of the Fractal Dimension of an image fragment. The algorithm receives for its input a fragment of satellite image whose its borders were identified. It is a binary image, just containing the information of the limits of the interest class. The input image is splitted in squares (or blocks) every time minor, counted in number of pixels. For each square size L, are counted the number of squares "N" that contain a piece of the image (it embroiders). The output generated is a file containing the values of the logarithm of L and the logarithm of N. At the end, it is made the linear regression of the data of that file, and the angular coefficient of that straight line represents the Fractal Dimension of the image. The experiments were accomplished with the images classified by ML. That classified image was submitted to the detection of borders by the Method Canny (W. Gonzalez, 2000) in the Software MATLAB. The image was submitted to the detection of borders several times, modifying the thresholds of the method Canny, in order to observe the results with more or less "noise" of the detection. The initial thresholds, given automatically by the Software, they were 0,0063 and 0,0156. These are, respectively Low Threshold and High Threshold (parameters), in other words, the thresholds minimum and maximum. After the detection of borders, they were cut out of the image areas according to the classes of interest. Those cut out areas were used as data of entrance of the algorithm of counting of blocks for Dimensão Fractal's determination. The results of those initial experiments are presented in the next item.

2.5 Results of the Experiments with Fractals

Table 1 illustrates the results obtained for the variation of the thresholds of the Fractais Dimension of the classes Not-forest and Deforestation.

Table 1: Results of Fractal Dimension

SAMPLE	LOW TRESHOLD	HIGH TRESCHOLD	No-Forest	Deforestment
1	0.0004	0.0010	1.53709412	1.46204114
2	0.0008	0.0020	1.53537869	1.45986021
3	0.0012	0.0030	1.53410149	1.45847464
4	0.0016	0.0040	1.53297484	1.45847464
5	0.0020	0.0050	1.53107572	1.45847464
6	0.0024	0.0060	1.52993512	1.45847464
7	0.0028	0.0070	1.52984762	1.45847464
8	0.0032	0.0080	1.52922928	1.45847464
9	0.0036	0.0090	1.52905297	1.45847464
10	0.0040	0.0100	1.52799046	1.45847464
11	0.0080	0.0200	1.51408172	1.46

3 INITIAL EXPERIMENTS WITH TAINHAS IMAGES

The image which were made the experiments described in this section referred to the Tainhas region in Rio Grande do Sul Province, that contains a National Preservation Forest (FLONA), with great concentration of pinus and araucaria. This image was obtained by CCD sensor of CBERS-II satellite. The UTM coordinates of latitute is 551050.191413 and 564050.191413 and longitude is 6735848.537342 and 6752628.537342. The image was submitted to the classifiers MAXVER and to RNAs, as in the previous work.They were defined 8 classes, for the identification of the main elements of the image: Field, Bare Soil, Road, Araucaria, Pinus, Native, Cloud and Shadow.

Using the same methodology used with the image of Rondônia, they were mounted bases for training and test of both methods. Of the 432 points in that the field truth is had, became separated in two bases of 216 points, each a containing 27 examples of each class.

After the training of each classifier, a confusion head office is set up on the test base, in order to if it verifies how many píxeis they were classified correctly and which píxeis were designated erroneously to other classes. The results of those head offices will be presented in the next section of that paper, that also shows the result of the classification of the whole image.

3.1 Results of Classification

Starting from the experiments accomplished with the chosen techniques had been generated the confusion head offices for both methods. The confusion matrix shows how much the classifier of images confuses a class with other.

For this the exits are compared generated by the methods for each píxel and the base of examples, that it possesses the field truth. The diagonal of the confusion matrix shows as the method got right, in other words, the pixels that were classified correctly in agreement with the field truth.

The Tables 2 and 3 show the result of the confusion head offices for the methods MAXVER and Neural Networks, respectively:

4 CONCLUSIONS AND FUTURE WORKS

In the accomplished study, being used the methods of ML and Neural Networks, it was verified that both methods didn't get to distinguish some areas of the image; to know, confusion between the classes Forest of Araucaria and Forest of Pinus. It is observed in the histograms of the distribution of the grayscale of the classes, that points certain classes that locate in the same band of values exist, what hinders to the nets neurais on top the learning of those information. Moreover, in this scope it is considered advantageous the use of Neural Networks in the classification of images, once it allows the incorporation of other types of information on the image, as the use of techniques that considers dimensions fractals and even topographical information of the image, being compared with ML, that consider only the grayscale of the component bands of the image to be classified. The use of the fractais intends to supply additional information them to allow a better identification of classes in that there is confusion with the classification methods used. It is noticed, for the detection of borders, that their surfaces tend to present different patterns between the classes. One of the main differences between an area of deforestation and one of no forest seen in it is the level of irregularity of their bor-

Table 2: Matrix of Confusion of Maximum Likelihood

-	Araucaria	Native	Pinus	Field	Bare Soil	Road	Cloud	Shadow
Araucaria	0	0	27	0	0	0	0	0
Native	0	27	0	0	0	0	0	0
Pinus	0	0	9	0	0	0	0	18
Field	0	0	8	0	0	19	0	0
Soil	0	8	0	0	19	0	0	0
Highway	0	0	0	1	0	26	0	0
Cloud	0	0	0	0	0	0	27	0
Shadow	0	1	0	0	0	0	0	26

Table 3: Matrix of Confusion of Neural Networks

-	Araucaria	Native	Pinus	Field	Bare Soil	Road	Cloud	Shadow
Araucaria	0	0	27	0	0	0	0	0
Native	0	27	0	0	0	0	0	0
Pinus	0	0	20	0	0	0	7	0
Field	0	0	9	9	9	0	0	0
Soil	0	0	0	0	27	0	0	0
Highway	0	0	0	9	0	18	0	0
Cloud	0	0	0	0	0	0	27	0
Shadow	0	0	0	0	1	0	0	26

ders. In fact, the areas deforested by the man tend to be more regularly delimited than those of savannah (no forest). In relation to the image of Tainhas, it is known that exist areas in which araucarias present like capons, while the pinus, that they were inserted in the area through the human action, have a more poligonal aspect. In spite of the possibility of the borders themselves don't constitute in fractals, in the strict sense of the term, it is noticed that the use of estimates of dimensions fractals can accuse such difference, resulting in larger values for savannahs and smaller for deforestations (due to the human action). That was verified in the results obtained until the moment. The information regarding dimension fractal of the classes will be applied in the improvement of the accuracy in the identification of areas of interest together with ML and ANNs, constituting a hybrid model of classification of satellite images. It is waited through this work that is developed a robust classifier that it supplies the needs of the user's accuracy, reducing the parametrization difficulties and deficiencies found in the conventional methods of classification of images by pixel.

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