

DIGITAL IMAGE PROCESSING USING TECHNIQUES OF MATHEMATICAL MORPHOLOGY

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ABSTRACT

The cartographic products of Brazil are around 30 years outdated. The present work describes an alternative to diminish this problem by using the coupling of products of Remote Sensing and techniques of mathematical morphology (MM). The images of the Remote Sensing can be considered as a source of data for studies in many areas, such as the cartography, urban planning, agriculture and environment. Such use can be justified by its rapidity, efficiency, regularity in the attainment of data and low cost. In addition, an important component is the technique of Digital Processing of Images (DPI). In this work it was used MM theory for extraction of draining and new calculation of the reservoir of the hydroelectric power plant, assigned Mascarenhas de Moraes, located in the Rio Grande River in Minas Gerais State, Brazil. The obtained results are promising and evidenced the great potential of mathematical morphology in the area of cartography.

Keyword: Mathematical Morphology, Cartographic Features, Update, Digital Image Processing, Remote Sensing

1. INTRODUCTION

The requirement of alternative methods to update many areas in cartography in Brazil leads to the source for fast and economic methods. According to Lillesand & Kiefer [1], Remote Sensing can be defined as being the science and art able to offer information on an object, an area or phenomenon useful for analysis of the data gotten with great success without any physical contact with this object, this area or this phenomenon.

Amongst the great versatility involved in the Digital Processing of Images (DPI) that could be used in this research, the theory of the Mathematical Morphology was chosen, taking into consideration the research developed by Matheron and its collaborators- 1964, in the superior school of Mines of Paris. The Mathematical Morphology recognizes the area that studies topological and structural properties of objects. From these images is able to describe quantitatively the geometric structure and functions as one technique taking in consideration the conception of algorithms in the DPI area, basing in morphologic detectors of edges and filters.

In this work the manipulation of the images obtained from a reservoir of the hydroelectric power plant, assigned Mascarenhas de Moraes, located in the Rio Grande River in Minas Gerais State, Brazil, was carried through the box of tools (“Toolbox”) of Mathematical Morphology developed by the SDC Information Systems, which was connected to the software MATLAB 7.0.

2. OBJECTIVE

The aim of the present work was to develop a morphologic routine appropriate to extract draining from digital images for the calculation of flooded area and of the reservoir of the Hydroelectric power plant, assigned Mascarenhas de Moraes, located in the Rio Grande River in Minas Gerais State, Brazil.

3. THEORETICAL RECITAL

Mathematical morphology: The Mathematical Morphology was originate from the joint research of G. Matheron and J. Serra range, in 1964. The first theoretical knowledge was established in the period of 1964 and 1968, in conjunction with the Center of Mathematical Morphology, where I was created the School of Mines of Paris located in Fontainebleau (France). According to Soille [2], the Mathematical Morphology can be defined as a theory for analysis of space structures. It is called morphology because it is aims lead to the ability to analyze the sharp objects. From mathematical point of view its direction is based on the analysis of the sets of theories, geometric integrals and boolean algebra. However, the MM is not only one theory, but also a powerful technique able to promote analysis of images.

The method of images analysis by Mathematical Morphology has as main objective to analyze the geometric structuring of the images from a defined and known rectangular mesh, called structuring element.

Toolbox: The mathematical morphology “toolbox” is a specific set of archives that use MATLAB as platform and are composed by morphologic operators developed by SDC Information System.

Structuring element: According to Facon [3], the structuring element is a set completely defined and known (shape, size), which is compared to the unknown set of the image by using a transformation. The result of this transformation allows evaluate the unknown set. This tool also makes use of some advantages as to the implementation simplicity. In this work (seccross) was used the structuring element in the form of mask in cross, and form of masks full (sebox). Figures 1 and 2 present the used structuring elements.

0	1	0
1	1.	1
0	1	0

Fig. 1: Mask in cross

1	1	1
1	1.	1
1	1	1

Fig. 2: Full mask

4. TEST AREA OF RESEARCH

To develop the work it was used a sub-picture satellite CBERS 2B, CCD sensor, band 4, dated 23/09/2008, having the feature of the hydroelectric reservoir of Mascarenhas de Moraes, which was located between the towns of Ibiraci and Sacramento, both in Minas Gerais, Brazil. Figure 3 illustrates the sub-image of the test area of research.

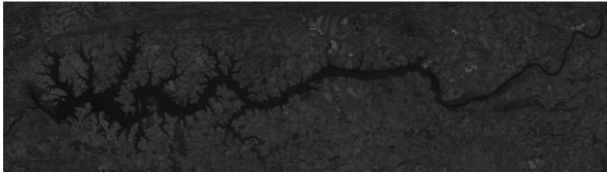


Fig. 3: Original image

5. METHODOLOGY

The flow diagram in Figure 4 shows the routine and sequence of operators used in the extraction of container.

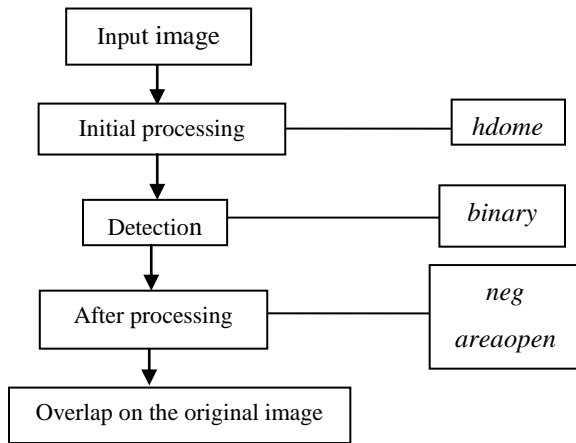


Fig. 4: Flowchart adopted for the extraction of the image without hydroelectric power plant

6. PRESENTATION AND ANALYSIS OF THE RESULTS

Features Extraction: Firstly, the original figure (3) was processed by operator applying the *hdome*. The function of this operation was to reinforce the values of brightness and contrast, which improved the drainage to be detected. The threshold was set at 60. Figure 5 illustrate these results.

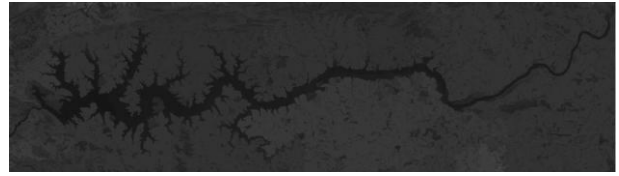


Fig. 5: Result of the application of the operator *hdome*

Still in the initial processing of the image, the operator was applied *addm* with threshold of 100, The operator has the task of saturating the pixel value, thereby altering its brightness value. Figure 6 illustrates the result.

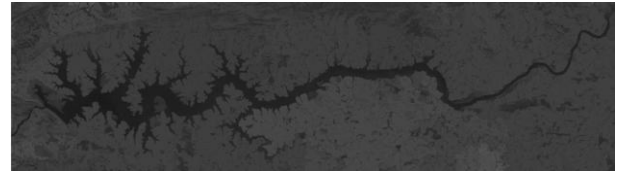


Fig. 6: Result of the application of the operator *addm*

After the initial step, the image was transformed in binary sample using the binary operator with threshold 130. The gotten result is shown in figure 7.

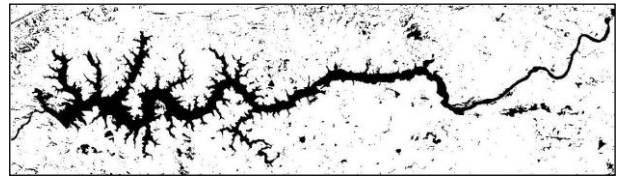


Fig. 7: Results from the application of the binary operator

In sequence the operator *neg* was applied with the objective to invert the tones of the image in order to be applied in the morphologic operators. This procedure can be observed in figure 8.

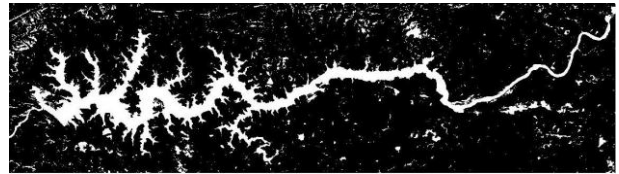


Fig. 8: Result from application of the operator *neg*

It is possible to see from the analysis of Figure 8, which an image with segmentation. In order to minimize this problem it was applied the operator *areaopen* thresholds of 10000. This operator helps the removal of all segmentation which is below the threshold adopted. The result of this last operator is presented in figure 9.

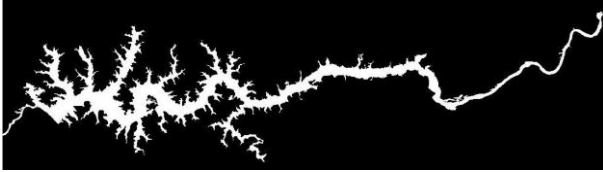


Fig. 9: Result obtained from application of the operator *areaopen*

An overlap between the original image and the final result image was made with the aim to verify the quality of the gotten result, which is presented in Figure 10. More importantly, it is the fact that the position of the draining had not modified after application of the morphologic operators.

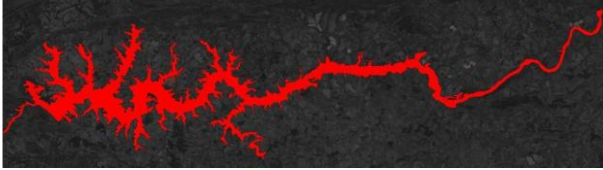


Fig. 10: Results containing the overlap of the processed image with the original one.

Areas Calculation: Taking into consideration that the spatial resolution of each pixel of the image of the CBERS 2B satellite is 20m x 20m, it was possible to determine the area of the reservoir with great resolution of 400 m².

Calculation of the Reservoir Area: From dam Mascarenhas de Moraes images it was found 623475 pixels, which multiplied by the pixel area, indicates a total area of 249,39 km² for the reservoir.

7. CONCLUSION

It is possible to conclude that the proposed methodology was successful for extraction of the draining and calculation of reservoir area. The use of morphologic tool in the area of Cartography could be an efficient alternative for extraction of the features. The developed routine presented good combination for the morphologic operators and structures elements, which allows detections of the draining with success.

The adopted thresholds had been based on the analysis of the histograms of the used images and the adequate choice of these thresholds is very important for the quality of the gotten results.

The comparison between the features using original and the present results (figures 10) indicates that there was no positional displacement between the features. The extraction of draining nets is important in the area of Cartography, therefore these feature can be used in conventional processes of update of cartographic products. This could be important for example to update of courses of rivers that had been deviated, delimitation of the extension and calculation of reservoirs area involved in hidroelectric power plants and other.

8. ACKNOWLEDGMENT

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