MATHEMATICAL MORPHOLOGY AND CANNY FILTERING EDGE, A COMPARISON BY USING HYPOTHESIS TESTING

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RESUMO – A borda do reservatório de Itaparica possui um contorno complexo e pode gerar erros supondo que a extração seja do tipo manual. O método de extração pelo filtro de Canny necessita de dois limiares para a definição da borda e o método de extração por morfologia matemática utiliza operadores de dilatação e erosão para isso. Este trabalho apresenta uma comparação da extração de bordas do reservatório de Itaparica. Utiliza-se a banda 4 do sensor OLI TIRS, orbita/ponto: 216/66 da data 02/01/2014 e compara-se a extração da borda pelo filtro de Canny (x) e o método de extração automática de imagem obtido a partir de operadores da Morfologia Matemática (y). O objetivo é verificar a precisão relativa de extração entre os dois métodos supondo teste de hipóteses e admitindo que o método de Canny é a extração correta.

ABSTRACT - Edge of the Itaparica reservoir has a complex contour and may generate errors if the extraction is by manual type. The extraction method by Canny filter requires two thresholds for the edge definition and Mathematical Morphology by extraction method using dilation and erosion operators for this. This paper presents a comparison of the edge extraction of Itaparica's reservoir. Band 4 of OLI TIRS sensor, orbit / point: 216/66 date 01.02.2014 is used and it is compared with the extraction of the Canny edge filter (x) and the automatic extraction method of image obtained from operators of Mathematical Morphology (y). The aim is to verify the relative accuracy of extraction between the two methods assuming hypothesis testing and assuming that the Canny method is the correct extraction.

1 INTRODUCTION

Itaparica's reservoir localization is showed in Figure 1. It can be seen that the reservoir has a complex contour and a manually extraction can generate errors. Edges extraction by mathematical morphology (MM) can be indicated to delimitation Itaparica's reservoir border.

This paper shows an edge comparison between Canny filter (*x*) and an automatic image extraction obtained from Mathematical Morphology operators method (*y*).

Details about Mathematical Morphology can be found in Serra (1982), Candeias (1997), Candeias (2013), Haralick, Sternberg and Zhuang (1987), Najman (2012) and Serra (1982). For Canny filter, more details can be found in Canny (1986) and Gonzalez and Woods (2010).

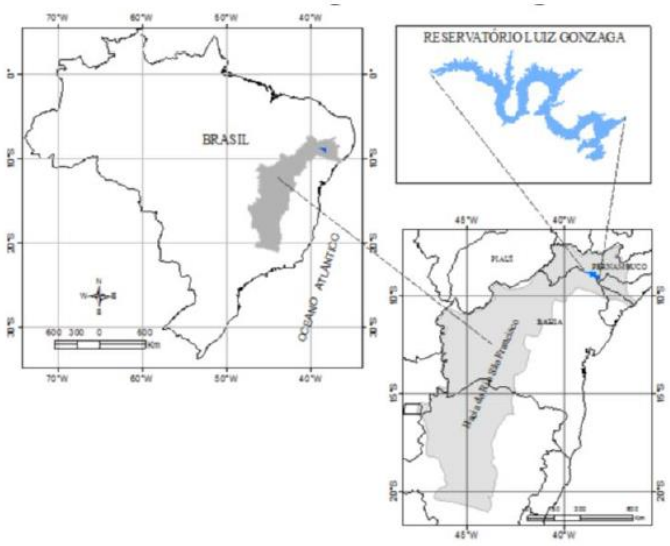


Figure 1 – Itaparica's reservoir localization.

The objective of this paper is to verify a relative accuracy of the MM automatic supposing that Canny Method is the reference.

2. METHOD

It is assumed that the white pixels from the automatic extraction image *y* belong to set *A* and the white pixels from the visual extraction image *x* belong to set *B* and both belong to a set *C*.

The ideal case is obtained when:

A=B and the worst case is obtained that when $A \cap B = \emptyset$.

Rule:

If an automatic extraction is good,

intersection of number of pixels NP($A \cap B$) is close to the union of NP($A \cup B$),

Otherwise, NP($A \cap B$) is low compared with NP($A \cup B$).

Where is the function that NP() computes the number of elements(pixels).

It is supposed that both extractions have some errors. Therefore, a distance tolerance is included in $A \cap B$. The tolerance is obtained by dilation of *x* and *y* by *b*. Where *b* is the structural element.

The methodology is defined in two steps:

a) obtain the segmentation of image by two processes: Canny (*x*) and by MM (*y*)

b) apply the Hypothesis' test with equations (1) to (8).

Hypothesis' test

With hypothesis' test we can define error region of type 1 (exceed error image), error region of type 2 (absence error image), agreement region of type 1 and agreement region of type 2.

Error region of type 1(e) called by exceed error image:

$$e = y - \delta_B(x) \quad (1)$$

Error region of type 2 (f) called by absence error image:

$$f = x - \delta_B(y) \quad (2)$$

Agreement region of type 2 (a_1) selection:

$$a_1 = x \wedge \delta_B(y) \quad (3)$$

Agreement region of type 1(a_2) selection:

$$a_2 = y \wedge \delta_B(y) \quad (4)$$

Where edge of Canny filter is called x and edge obtained by MM is called y. The next step is to compute the number of pixels NP() of each region defined above. Let NP(a) be the average of the pixel number of the agreement regions $a1$ and $a2$:

$$NP(a) = (a_1 + a_2)/2. \quad (5)$$

The number of pixels' percentage in each region is defined by:

a) Let NP(a)% be the degree of agreement given by:

$$NP(a)\% = NP(a)/T. \quad (6)$$

b) Let NP(e)% be the degree of error of type 1 given by:

$$NP(e)\% = NP(e)/T. \quad (7)$$

c) Let NP(f)% be the degree of error of type 2 given by:

$$NP(f)\% = NP(f)/T. \quad (8)$$

Where T = NP(a) +NP(e) +NP(f).

3. RESULTS

Let an example obtained to three structural elements applied to the equations (1), (2), (3) and (4):

I. The first one B_1 is equal a 3x3 matrix with the center in B(2,2);

II. The second one $B_2 = 2B_1$ is a matrix 5x5 with center in B(3,3);

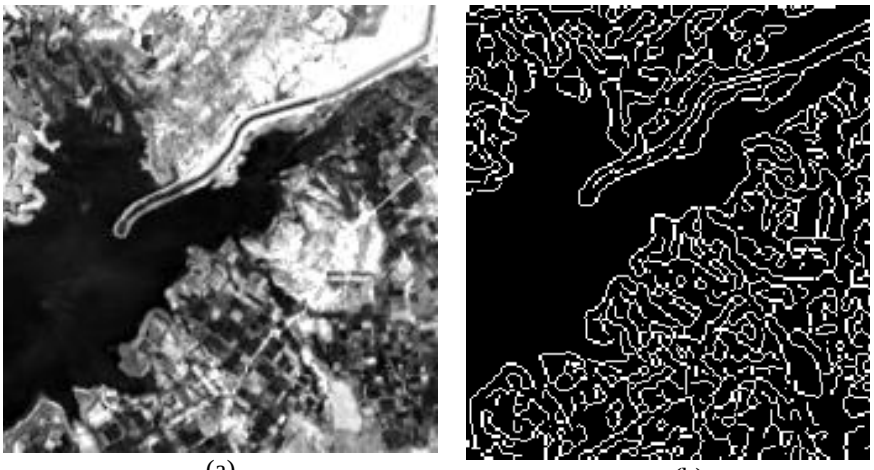
III. And finally the third one $B_3 = 3B_1$ with a matrix 7x7 with center in B(4,4).

The tolerance distance was considered through dilation by B, assuming some errors in automatic information extraction by MM (*y*), as well as Canny extraction (*x*). The larger B is, the larger the tolerance is, and more pixels belong to the agreement region. Table 1 shows the comparative results of two methods. NP(*a*)% is the degree of agreement and increases when B increases. On the other hand, NP(*e*)% is the degree of error of type 1 and decreases when *B* increases. NP(*f*)% is the degree of error of type 2 when and decreases when *B* increases.

Table 1. Percentage result for B_i, where i = 1,2 e 3

Structural element	**NP(*a*)%**	**NP(*e*)%**	**NP(*f*)%**
B_1	30.144	2.870	1.443
B_2	46.910	2.133	0.753
B_3	61.630	1.474	0.282

Figure 2 shows edge extraction with original band 4, Strong and not strong edges extracted by Canny, only strong edge extracted by Canny, edge extraction by MM supposing *B* equal 3x3, edge extraction by MM supposing *B* equal 5x5 and edge extraction by MM supposing *B* equal 7x7.



(a) (b)

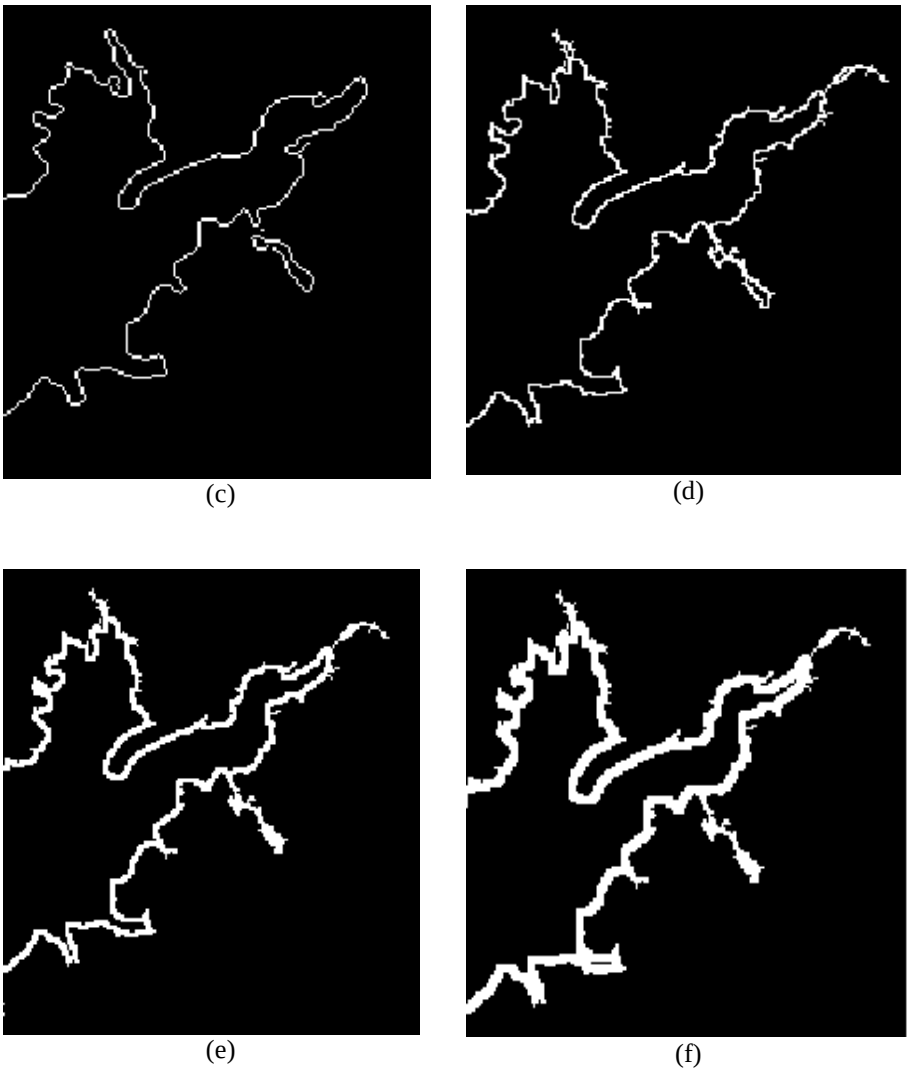


Figure 2 – Edge extraction. (a) Original band 4. (b) Strong and not strong edges extracted by Canny. (c) Only strong edge extracted by Canny. (d) Edge extraction by MM supposing *B* equal 3x3. (e) Edge extraction by MM supposing *B* equal 5x5 . (f) Edge extraction by MM supposing *B* equal 7x7.

4. CONCLUSION

Automatically Itaparica's reservoir edge extraction is obtained here. It's complex contour and may generate errors if the extraction in the manual type. The extraction method by Canny filter requires two thresholds for the edge definition and MM by extraction method using dilation and erosion operators for this. A comparison of automatic extraction with MM and structural element B_1 = Square $_{3x3}$, $B_2 = 2B_1$ and $B_3 = 3B_1$ and Canny filter is performed. Then the objective of this paper was to verify a relative accuracy by MM edge extraction and by Canny filter. The hypothesis' test adapted to MM approach was introduced. A distance tolerance was considered through dilation by B is, the larger the tolerance is, and more pixels belong to agreement region.

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