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Edge Detection of Satellite Images:A Comparative Study

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Abstract

Edge detection is a very important method in digital image processing and computer vision.There are various methods for edge detection .In this paper, an improved method for edge detection (lower constructor with laplacian operator) has compared withmorphological operator, specifically for the edge detection of satellite images.

Keywords:*Edge Detection, Digital Image Processing, Morphological Operator, Lower Constructor with Laplacian Operator, Satellite Images.*

1. Introduction

Edges provide important information towards human image understanding .It is the most important processing step in human picture recognition system.Now-a-days,Edge detection is a big challenge for image processing scientists .Edge detectionprocedure is used to find the discontinuities in depth, discontinuitiesin surface orientation, changes in material properties andvariations in scene illumination.

There are different ways to perform edge detection.But, most of the methods may be grouped into either Gradient and Laplacian,DerivativeApproach and PatternFittingApproach, orsearch-based and zero-crossing based.There are many traditional methods for edge detection[3] such asSobeledge detection method, Canny edge detection method, Prewitt edge detection method, Laplician of Gaussian edge detectionmethod, Robert edge detection method.

The edge detection methods that have been used generally differ in the types of smoothing filters that are applied and the way the measures of edge strength are computed.Many edge detection methods rely on the computation of image gradients, they also differ in the types of filters used for computing gradient estimates in the x- and y-directions[2].

2. Morphological Operators

Morphology is a technique for edge detection .It is a theory and techniquefor analysis and processing of geometrical structures, based onset theory. It was primarily developedfor binary images and later extends to grey scale functionsand images.

The different morphological operators are Dilation, Erosion,Opening,Closing [7].Dilation is the maximum value in the window.Erosion is the minimumvalue in the window .The image after dilation will be darker thanthe original image.Opening and closing both parameters are formed by usingdilation and erosion. In opening, image will be erodedand then it will be followed by dilation.In closing, first step will be dilation and then result of this isfollowed by erosion.All above operators perform their tasks by using structuringelements, which is a matrix of 0’s and 1’s.structuring elements
have various sizes and shapes.

If M is a white and black picture and N is a structure element, then the dilation of the base of N on the image of M is given as:

$$(M \oplus N)(x, y)=\max\{M(x-s, y-t)+N(s,t)\}$$

Dilation is an operator that grows and thickens the objects in a binary image. Erosion operator for M,N sets is given as:

$$(M\ominus N)(x,y)= \min\{M(x+s, y+t)-N(s,t)\}$$

Erosion makes small or makes the around of an image thin. Like dilation operator the how andthe amount of the erosion is controlled by the structure elements. Opening operator on the M set by means of structure elements N with the relation of MoN is given as:

$$M \circ N = (M \oplus N) \oplus N$$

Closing operator makes smooth for some parts of the periphery but on the contrary the Openingoperator usually mixes the broken hybrids and omits the small details and fills the spaces of objects periphery classing operator on M and N sets is given below:

$$M\ominus N \subseteq M \subseteq M \oplus N$$
$$M \circ N \subseteq M \subseteq M \bullet N$$

Morphology edge detection algorithm uses basic operator such as closing, opening, dilation,erosion given as:

$Ed(M)=(M \oplus N) - M$
$Ee(M)=M - (M \ominus N)$

Ed (M) is an image edge which is achieved by using the subtract of dilation image from the mainimage and Ee (M) is the subtraction of the main image from erosion image [5].With noticing the former relations we observe that dilation and closing make the shape of theimage big where as erosion and opening makes the shape of the image small so we can use these exclusivity for finding the edges.Morphology gradient of the image is provided below:

$G(A)=(M \oplus N) - (M \ominus N)$

3. Lower Constructor With Laplacian Operator

Basically the noise can be easily suppressed and the edges can be detected in an effective manner by using lower constructor with laplacian operator method.

The lower constructor is a generalization of the tn-processing. A t-norm T: $[0, 1]^2 \rightarrow [0, 1]$ is an associative, commutative, increasing function, such that, T(1, x) = xfor all x ∈ [0, 1]. At-norm Tis called idempotent if T(x, x) = xfor all x ∈[0, 1].

The four basic *t*-norms are as follows

1. The minimum $T_M(x,y)=\min(x,y)$.
2. The product $T_P(x, y) = x \cdot y$.
3. The Łukasiewiczt-norm $T_L(x, y) = \max(x + y - 1, 0)$.
4. The nilpotent minimum t-norm
5. $T_{nM}(x, y) = \min(x, y)$, *if x +y > 1*

0, otherwise.

- Let R ∈ F(X × Y) be an FR. Consider two t-norms T1 and T2 and two values n,m∈ N so that n ≤ P −1/2 , and m ≤ Q−1/2 .We define the lower constructor associated with T1 , T2 , n, and m in the following way:
- $L^{n,m}$T1 ,T2 : F(X × Y) → given by

$L^{n,m}$T1 ,T2 [R](x, y) =
$T_1^{m,n}(T_2(R(x - i, y - j),R(x,y)))$
i=-n
J=-m
for all (x,y)∈(X,Y)

The Algorithm begins with reading an M x N image. The first set of nine pixels of a 3x3 window are chosen with central pixel having values (2,2) i.e. for each pixel(i,j) we are taking the 8 neighbourhood of (i,j).After the initialization, the pixel values are initially marked as edge pixel after an observation to the 8 neighbourhood. After the subjection of the pixel values the algorithm generates an intermediate image using a construction method stated below. It is checked whether all pixels have been checked or now, if not then first the horizontal coordinate pixels are checked. If all horizontal pixels have been checked the vertical pixels are checked else the horizontal pixel is incremented to retrieve the next set of pixels of a window. In this manner the window shifts and checks all the pixels in one horizontal line then increments to check the next vertical location.

After edge highlighting image is subjected to another set of condition with the help of which the unwanted parts of the output image of such type are removed to generate an image which contains only the edges associated with the input image. For an input image A and an output image B of size M x N pixels respectively we have the following set of conditions that are implemented to detect the edges pixel values.

Input: An image A of M x N pixels (Phase 1)
Output: An image B of M x N pixels

```
Initial Edge Detection (A, B) using Lower Constructor
For I←2 to M-1
  For J←2to N-1
    If A (I-1, J)>A (I-1, J+1)
      Then If A (I-1, J-1)>A (I, J)
        Then If A (I, J-1)>A (I+1, J-1)
          Then
            B (I-1, J+1) ←0
            B (I, J) ←0
            B (I+1, J-1) ←0
  End For
End For
For I←2 to M-1
  For J←2to N-1
    If B(I-1,J)=255& B(I,J)=0& B(I+1,J)=255& B(I,J-1)=255
      Then B (I, J) is minimum and highlighted as edge
initially.
End For
End For
```

In the above algorithm Lower construction[1] is used but not after fuzzification as after fuzzification the membership values would become fractions that can't be stored in unsigned char. Hence the same technique of min construction is used but on true picture and taking into consideration 8-nbd of a pixel (i,j). We can observe in the above algorithm written for a particular fuzzy condition that the nesting of statements is done in a manner that only the edge associated pixels are granted black

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pixel values and initially min valued edge pixels are given white value. These pixels are initially marked as edge.

Phase 2. Input: An image B of size MxN
Output: Edge image of size MxN

We now use Laplacian operator [4] on the intermediate image to get the edge image. And In this way whatever image is being constructed is compared with edges found on same image by other existing techniques.

Laplacian operator which is stored in a 5x5 array is given as:

$$\begin{bmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 2 & 1 & 0 \\ 1 & 2 & -16 & 2 & 1 \\ 0 & 1 & 2 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{bmatrix}$$

Fig.1:Laplacian Operator Mask

4. Diagrammatic Representation of Proposed Methodology

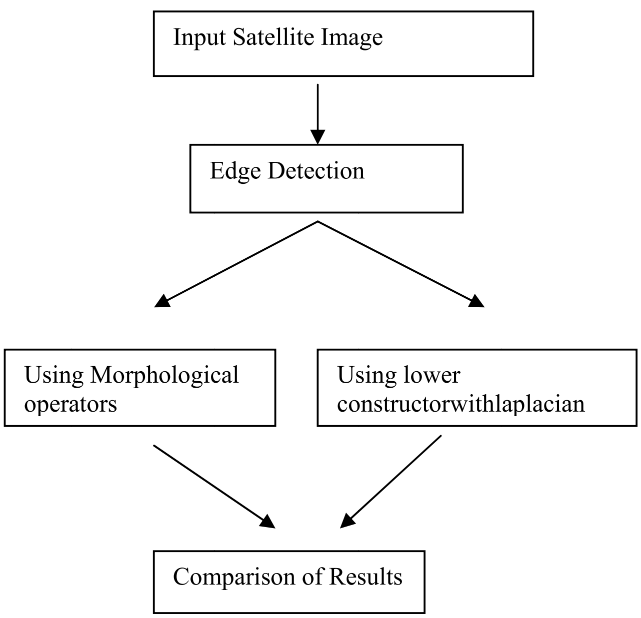

Fig. 2: Diagrammatic Representation of Proposed Methodology

5. Experimental Results

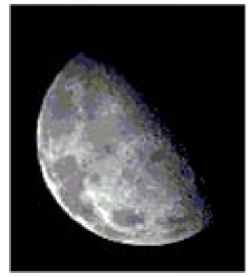

Fig. 3: Original Image

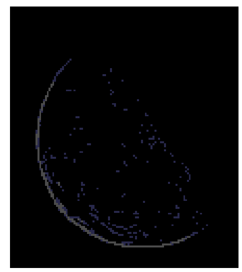

Fig. 4: Edge Detection using Morphological operator

Fig. 5: Edge Detection using Lower Constructor with Laplacian operator

From the result analysis, Fig. 3 represents the original image for edge detection. Fig. 4 represents the result of edge detection using Morphological Operator and Fig. 5 represents the result of edge detection using LowerConstructor with Laplacian Operator.

6. Conclusion

In this paper, the methods to find the edges associated with the satellite image has been implemented.From theexperimental results, it is concluded that the edge detection using lower constructor with laplacian operator provides better result.

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