Result Analysis of Edge Detection of Brighter Satellite Images: A Comparative Study of New and Existing Techniques

Sasmita Mishra , Kalyan Kumar Jena , Sarojananda Mishra

Abstract— **Edge detection is a very important as well as essential method in digital image processing and computer vision.It is a widely used technique in image processing for edge detection of different Gray-scale and color image. There are various methods for edge detection. The goal of edge detection is to mark the points in a digital image at which the luminous intensity changes sharply. Sharp changes in image properties usually reflect important events and changes in properties of the world. These include discontinuities in depth, discontinuities in surface orientation, changes in material properties and Variations in scene illumination**. **In this paper, a new method for edge detection of images is presented. Here, an improved method for edge detection (Upper constructor with LOG operator) has compared with morphological operator, specifically for the edge detection of brighter satellite images.**

Index Terms **Edge Detection , Digital Image Processing, Upper Constructor with LOG Operator , Morphological Operator , Satellite Images**.

I. 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 detection procedure is used to find the discontinuities in depth, discontinuities in surface orientation, changes in material properties and variations in scene illumination.

There are different ways to perform edge detection. But, most of the methods may be grouped into either Gradient and Laplacian , Derivative Approach and Pattern Fitting Approach, or search-based and zero-crossing based .There are many traditional methods for edge detection[1] such as Sobel edge detection method , Prewitt edge detection method ,Canny edge detection method , Laplacian of Gaussian edge detection method , 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].

II. MORPHOLOGICAL OPERATORS

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

The different morphological operators are Dilation, Erosion, Opening ,Closing [7].Dilation is the maximum value in the window.Erosion is the minimum value in the window .The image after dilation will be darker than the original image. Opening and closing both parameters are formed by using dilation and erosion. In opening, image will be eroded and then it will be followed by dilation. In closing, first step will be dilation and then result of this is followed by erosion. All above operators perform their tasks by using structuring elements, 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 and the 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 M o N is given as:

$$M \text{ o } N = (M \oplus N) \oplus N$$

Closing operator makes smooth for some parts of the periphery but on the contrary the Opening operator usually mixes the broken hybrids and omits the small details and fills

491

the spaces of objects periphery classing operator on M and N sets is given below:

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

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

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

Ed (M) is an image edge which is achieved by using the subtract of dilation image from the main image 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 the image 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:

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

III. UPPER CONSTRUCTOR WITH LOG OPERATOR

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

The *upper 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, $T(0, x) = x$ for all $x \in [0, 1]$. A t-norm T is called idempotent if $T(x, x) = x$ for all $x \in [0, 1]$. The four basic *t*-norms are as follows

1. The maximum $T_M(x,y)=\max(x,y)$.
2. The probabilistic sum $T_P(x, y) = x+y-x.y$
3. The Łukasiewicz t-norm
   $$T_L(x, y) = \min(x + y, 1).$$
4. $T_{nM}(x, y) = \max(x, y),$ if $x + y < 1$
   1, otherwise.
- Let $R \in F(X \times Y)$ be an FR. Consider two t-conorms T1 and T2 and two values n,m $\in$ N such that $n \leq P -1/2$, and $m \leq Q-1/2$ .We define the upper constructor associated with T1 , T2 , n, and m in the following way:
- $L^{n,m}T1, T2 : F(X \times Y) \rightarrow F(X \times Y)$ 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 $(x,y) \in (X,Y)$

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 Upper 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 maximum and highlighted as edge initially.
    End For
End For

In the above algorithm Upper construction [3] 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

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 LOG 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. LOG 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: LOG Operator Mask

IV. DIAGRAMMATIC REPRESENTATION OF PURPOSED METHODOLOGY

Input Satellite Image

Edge Detection

Using Morphological operators

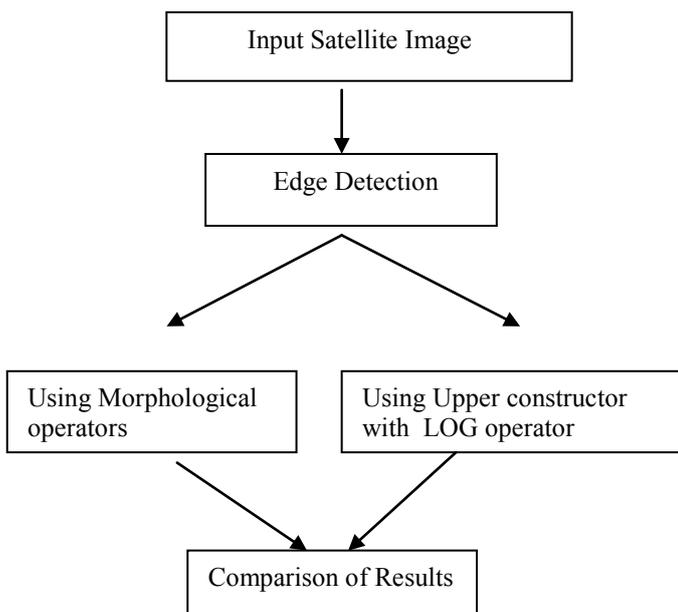Using Upper constructor with LOG operator

Comparison of Results

Fig. 2: Diagrammatic Representation of Purposed Methodology

V. EXPEIMENTAL RESULTS

Fig. 3: Original Image

Fig. 4: Edge Detection using Morphological operator

Fig. 5: Edge Detection using Upper Constructor with LOG 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 Upper Constructor with LOG Operator.

VI. CONCLUSION

In this paper, the methods to find the edges associated with the satellite image has been implemented. From the experimental results, it is concluded that the edge detection using Upper constructor with LOG operator provides better result for brighter satellite images.

REFERENCES

[1] H. Bustince,E. Barrenechea, M. Pagola and R. Orduna, "Construction of interval type-2 fuzzy images to represent images in gray scale:false edges ," *in Proc. IEEE Int. Conf. Fuzzy Syst. , London, U.K.*, PP. 73-78,2007.

[2] H. Bustince,E. Barrenechea, M. Pagola and J. Fernandez, "Interval-valued fuzzy sets constructed from matrices:Application to edge detection *," IEEE Trans. Fuzzy Sets Syst.*, vol. 160, pp.1819-1840, 2009.

[3] Edurne Barrenechea , Humberto Bustince, Member, IEEE, Bernard De Baets,And Carlos Lopez-Molina, Student Member, IEEE, "Construction Of Interval-Valued Fuzzy Relations With Application To The Generation Of Fuzzy Edge Images," *IEEE Transactions On Fuzzy Systems*, vol. 19, no. 5, pp. 819-830 , October 2011.

[4] Mitra Basu, Senior Member, IEEE, "Gaussian-Based Edge-Detection Methods*," IEEE Transactions On Systems, Man, And Cybernetics—Part C: Applications And Reviews*, vol. 32, no. 3, August 2008.

[5] Zhao Yu-qian, Gui Wei-hua, Chen Zhen-cheng, Tang Jing- tian and Li Ling-yun,"Medical Images Edge Detection Based on Mathematical Morphology," *in Proc. IEEEE MBS*, pp. 6492-6495 , 2005.

[6] Hui LI , Pengfeng XIAO , Xuezhi FENG , Chunjing WEN , Chongya JIANG"Multiscale Feature Detection of Multispectral Remotely Sensed Imagery in Wavelet Domain," *IEEE* , 2009.

[7] Sankar Krishnamurthy,"Histogram based Morphological Edge Detector," *IEEE Transaction on Geosciences and Remote Sensing* , vol.32, no.4 , July 1994.

[8] Morris o.;M.Lee," A unified method for segmentation & edge detection using graph theory," *Acoustics ,Speech & Signal processing ,IEEE international conference,ICASSP'86*,vol.11, pp-2051-2054, Apr.1986.

[9] P.J.Symonds,"A new technique for automatically segmenting images of the surface froth structures thatare prevalent in industrial flotation cells," *IEEE transaction*,1992.

[10] Stamatia Giannarou and Ania Stataki., "Edge Detection Using Quantitative Combination ," *IEEE transactions on signal processing system and implementation* , pp. 359-364, November 2000.

[11] J.C. Bezdek,R. Chandrasekhar and Y. Attikiouzel, "A geometric approach to edge detection *," IEEE Trans. Fuzzy Syst.*,vol.6,no.1,pp.52-75,Feb.1998.

[12] M. Basu, " Gaussian-based edge-detection methods: A survey ," *IEEE Trans. Syst. ,Man, Cybern. C, Appl. Rev.*, vol. 32, no. 3, pp. 252-260, Aug.2002.

[13] G. Deschrijver, C. Cornelis and E.E. Kerre, "On the representation of intuitionistic fuzzy t-norms and t-conorms ," *IEEE Trans. Fuzzy Syst.*, vol.12 , no.1, pp.45-61, Feb.2004.

[14] J.M Mendel,R.I. John and F. Liu, "Interval type-2 fuzzy logic systems made simple ," *IEEE Trans. Fuzzy Syst.* ,vol. 14,no. 6, pp. 808-821, Dec. 2006.

[15] R. Medina-Carnicer,A. Carmona-Poyato,R. Munoz-Salinas and F. J. Madrid-Cuevas, "Determining hysteresis thresholds for edge detection by combining the advantages and disadvantages of thresholding methods ," *IEEE Trans. Image Process.* , vol. 19, no. 1 , pp. 165-173, Jan. 2010.

[16] Q. Liang and J.M. Mendel, "Interval type-2 fuzzy logic systems:Theory and design ," *IEEE Trans. Fuzzy Syst.*, vol. 8, no. 5, pp. 535-550, Oct. 2000.

[17] P.J.Symonds,"A new technique for automatically segmenting images of the surface froth structures that are prevalent in industrial flotationcells," *IEEE transaction*,1992.

[18] R. Touzi, Armand L. and P. Bousquet, "A statistical and Geometrical Edge Detector for SAR Images," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 26, no. 6, Nov. 1988.

[19] Gholamali RRM and Majid, "A Comparison of SUSAN and sobel edge detection in MRI images for feature extraction," *IEEE transaction on Information and Communication Technologies,* pp. 1103-1107, 2006.

[20] Ganesan P and Rajini V," Segmentation and edge detection of color images using CIELAB color space andedge detectors," *Emerging Trends in Robotics and Communication Technologies (INTERACT), International Conference on. IEEE*, pp.393-397,2010.

[21] Sharifi M, Fathy M and Mahmoudi MT ,"A Classified and Comparative Study of Edge Detection Algorithms," *IEEE, International conference on Information Technology: Coding and Computing*, pp.117-120,2002.

[22] Seif A ," A hardware architecture of Prewitt edge detection. Sustainable Utilization and Development in Engineering and Technology (STUDENT)," *IEEE Conference, Malaysia*, pp. 99-101,2010.

[23] Jinbo Wu, Zhouping Yin and Youlun Xion, "The Fast Multilevel Fuzzy Edge Detection Of Blurry Images," *IEEE Signal Processing Letters*, vol. 14, no. 5, pp.344-347, May 2008.

[24] Bo Lia. , Aleksander Jevtic and Ulrik Soderstrom , "Fast Edge Detection by Center of Mass," *IEEE intelligent Systems and Image Processing* , 2013.

[25] J. Canny, "A computational approach to edge detection," *IEEE Trans. Pattern Analysis and Machine Intelligence*, vol. 8, no. 6, pp. 679-698, 1986.

494

AUTHORS PROFILE

Prof.Dr.(Mrs.) Sasmita Mishra,
Prof. ,
Dept. Of CSEA,IGIT,Sarang,India.

Ph. D. (UU), MCA (SU), M.E.(SU)
LIMISTE, Data   Structure,
Programming, Language, RDBMS,
Operating System, Graphics

Mr. Kalyan Kumar Jena,
 Asst. Prof. ,
Dept. Of CSEA,IGIT,Sarang,India.

B.Tech(CSE),M.Tech(CSE.),
Ph.D.(Continuing)
 Research Area: Image Processing
(Edge Detection)

Prof.(Dr.) Sarojananda Mishra,
Prof. & Head of the Department,
Dept. Of CSEA,IGIT,Sarang,India.

MCA(S.U.), M. Tech (II.T. Delhi),
Ph.D.(UU), LMISTE, AMAIMA,
Fractals and Graphics, System
Dynamics, MIS,   Operation
Research, Networking,Computer
Programming