



Comparative Analysis of Various Edge Detection Techniques Used in Image Processing

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Abstract— Edge detection is an important step in digital image processing and is mainly used in the application of feature extraction. One major application of edge detection is in the field of medical image processing. Edge detection is basically the process of detection of those regions in the image where there is an abrupt change in the brightness of the image. In this thesis, various edge detection methods are described and compared.

Keywords— Canny edge detection, Morphology, Operators, Gradient, Laplacian

I. INTRODUCTION

Since from the last few decades, application of computer vision is enormously increasing in almost all fields of life. From sorting products in the industry, to surveillance in the security zones, car parking systems to medical image processing. Therefore, automatic visual inspection of the images is very important as it is used in industry for detecting defects in textile design, glass industry and steel reolling mills, due to the fact that comparison of numbers is more easy than comparison of images. Thus, image analysis is very important and necessary. One main image analysis technique is the edge detection process, in which abrupt change in the image intensity is detected. Different techniques are used for detecting the edges in which the most commonly used and computationally light technique is the Linear Time Invariant filters. In case of first order filters, the aim is to find first order derivative in which its magnitude is high. The other well known techniques for edge detection are grouped mainly in two categories: search based techniques and zero crossing algorithms. In zero crossing detectors, second order derivative is computed for edge detection while in case of search based methods first order derivatives are computed [1]. The most well known conventional methods like Sobel, Canny, Prewitt, and Laplacian belong to one of the above classes. The edge detection aims to identify points in a digital image at which the image brightness changes sharply or abruptly. Image edge detection mainly deals with extracting edges in an image by identifying pixels where the intensity variation is very high. It is a fundamental tool used in most image processing applications which is used to obtain information from the frames as a precursor step to the feature extraction and the object segmentation. The outlines of an object and boundaries between the objects in the image and the background are detected with this process. The edge is the set of the pixel, whose surrounding gray is abruptly or sharply changing. The internal characteristics of the edge which is dividing the same area are the same, where as different areas have the different characteristics[4]. The edge is the basic feature of any digital image. There is a lot of information of the image in the edge of that image. Edge detection refers to the process in which the characteristics of discrete parts are extracted by the difference in the image characteristics of the object, and then the image area is determined according to the closed edge. Since different edge detectors work better under different conditions, it would be ideal to have an algorithm that makes use of multiple edge detectors, applying each one when the scene conditions are most ideal for its method of detection. We tested various edge detectors that use different methods for detecting edges and compared their results under a variety of situations to determine which detector was preferable under different sets of conditions.

II. CLASSIFICATION OF EDGE DETECTORS

1. Sobel Operator: It performs 2-D spatial gradient measurement on an image. The operator consists of a pair of 3x3 convolution mask. One mask is simply the otherrotated by 90°. Both masks can be applied to the images independently and the output magnitudes are combined to find the absolute magnitude of the whole image.

-1	0	+1
-2	0	+2
-1	0	+1

Gx(a)

+1	+2	+1
0	0	0
-1	-2	-1

Gy(b)

Fig 2.1 (a-b): Sobel Masks

2.Prewitt Operator: Prewitt edge detection method is almost similar to the Sobel operator. In this case, 3x3 masks are used to find the gradients in x and y directions. This method is suitable for images with high resolution and is computationally more efficient. Masks of Prewitt detector are shown in Figure 2.2

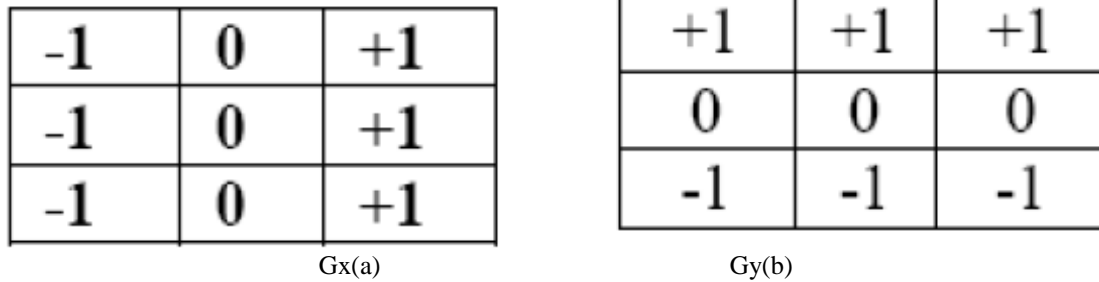


Fig 2.2 (a-b): Prewitt Masks

3.Roberts Operator: Roberts operator performs 2-D spatial measurement of the gradient on an digital image. It results in highlighting of the regions of high spatial frequency which corresponds to the edges. Being the differential operator, the Roberts operator is to approximate the gradient of an image through the discrete differentiation is obtained by calculating the sum of the squares of the differences between diagonally adjacent pixels. The cross convolution mask is shown in figure2.3

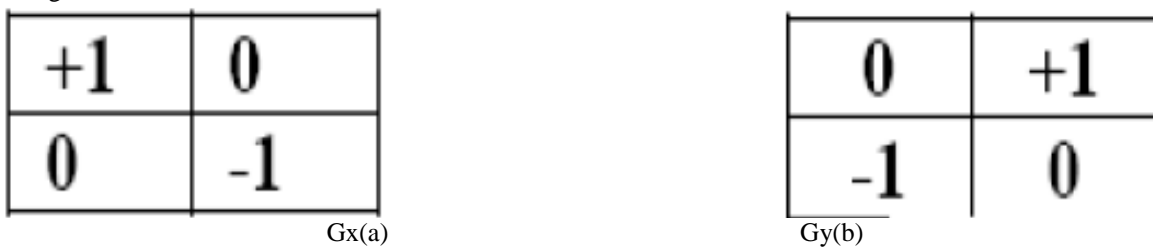


Fig 2.3 (a-b):Robert Masks

4. Canny Edge Detector: Canny is another well known conventional edge detection algorithm which is popular due to its optimum performance. It is basically an optimization problem with constraints. Three different criteria are addressed in this detector i.e. localization, low error rate and single response to the single edge. These parameters were implemented by using the canny operator. It also having good localization property, means the detected edges are much closer to the real edges. The response of this detector is also good, as the original edge does not result in more than one detected edge. The gradient magnitude and direction is calculated by using first order finite differences.

III. COMPARISON OF EDGE DETECTORS

In the past two decades several algorithms have been developed to extract edges within digital images but their functionalities and performances are not the same. In spite of all the efforts, none of the proposed operators are fully satisfactory in real world. The availability of well-defined quality criteria is important.

There are five different criteria that are typically used for testing the quality of an edge detector:

- The probability of a false positive (marking something as an edge which isn't an edge)
- The probability of a false negative (failing to mark an edge which actually exists)
- The error in estimating the edge angle
- The mean square distance of the edge estimate from the true edge
- The algorithm's tolerance to distorted edges and features such as corners and junctions (Criteria taken from [5])

However, in order to determine the third and fourth criteria, an exact map of the edges in an image must be known, and in general this is not available. It is also not plausible to assume that some "exact map" of all the edges can even be constructed. Therefore, the third and fourth criteria are not very useful. Additionally, corners and junctions simply are not handled well by any edge detector and must be considered separately. Therefore the fifth criterion is not very useful either.

The most important criteria are the first two, as it is much more important to have the proper features labeled as edges than having each edge exactly follow what would be considered the "ideal" edge or being able to handle special features such as corners and junctions.

IV. IMPLEMENTATION AND RESULTS

4.1 Simulink Model for Edge detection of Seed

We applied all the above mentioned algorithms to different images like rice and seed.

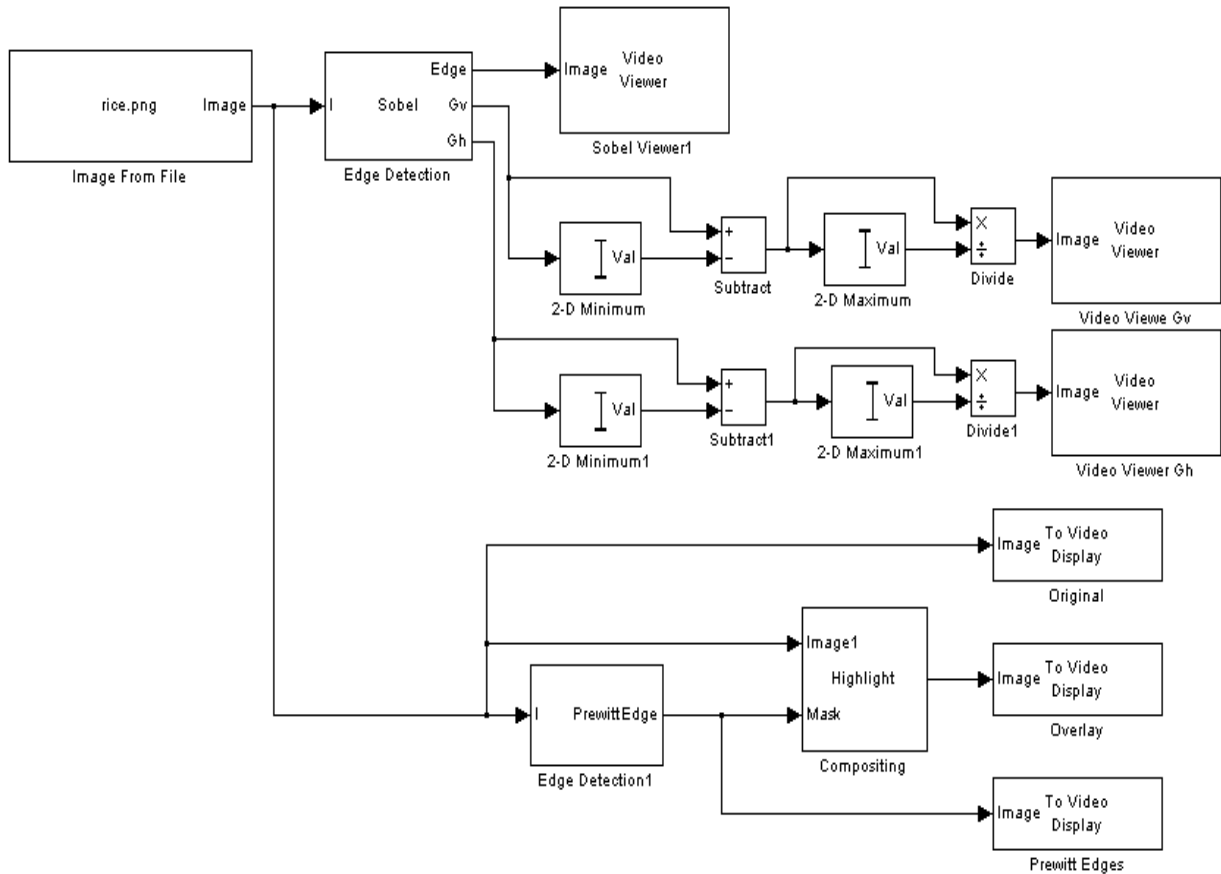


Fig 4.1 Simulink Model of Edge detection using Sobel and Prewitt Method

4.1.1 Simulation Results

Various simulation result is displayed for Sobel and Prewitt Method. We analyse the edge image from the sobel and prewitt method

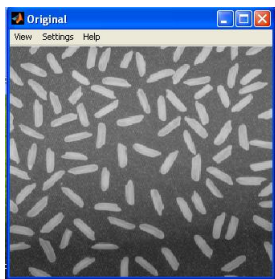


Fig 4.1.1 The Video Viewer window displays the original image

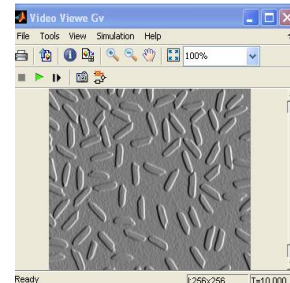


Fig 4.1.2 window displays the edges of the rice grains in white and the background in black

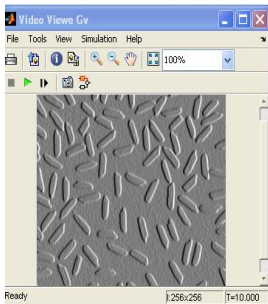


Fig 4.1.3 Video Viewer Gv display

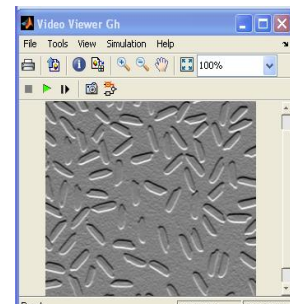


Fig 4.1.4 Video Viewer Gv display

The Video Viewer Gv window displays the intensity image of the vertical gradient components of the image. You can see that the vertical edges of the rice grains are darker and better defined than the horizontal edges. The Video Viewer Gh window displays the intensity image of the horizontal gradient components of the image. In this image, the horizontal edges of the rice grains are more well defined

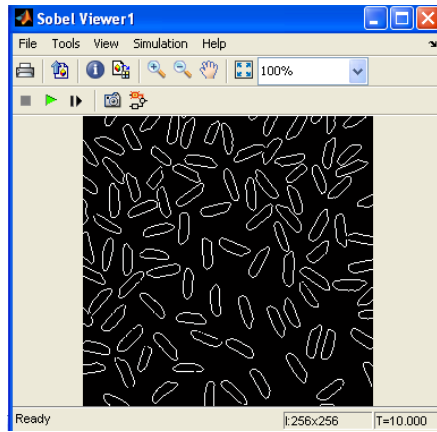


Fig 4.1.5 Sobel Video Viewer display

The Edge Detection block convolves the input matrix with the Sobel kernel. This calculates the gradient components of the image that correspond to the horizontal and vertical edge responses. The block outputs these components at the Gh and Gv ports, respectively. Then the block performs a thresholding operation on the gradient components to find the binary image. The binary image is a matrix filled with 1s and 0s. The nonzero elements of this matrix correspond to the edge pixels and the zero elements correspond to the background pixels. The block outputs the binary image at the Edge port.

The matrix values at the Gv and Gh output ports of the Edge Detection block are double-precision floating-point. These matrix values need to be scaled between 0 and 1 in order to display them using the Video Viewer blocks. This is done with the Statistics and Math Operation blocks

4.2 Simulink Model for Edge detection of Seed

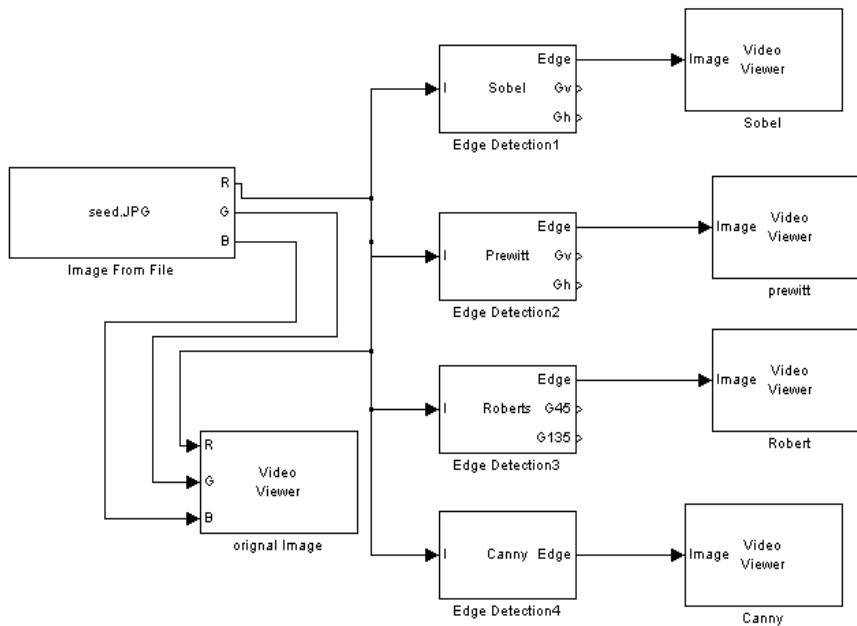


Fig 4.2 Simulink Model for various edge detection techniques

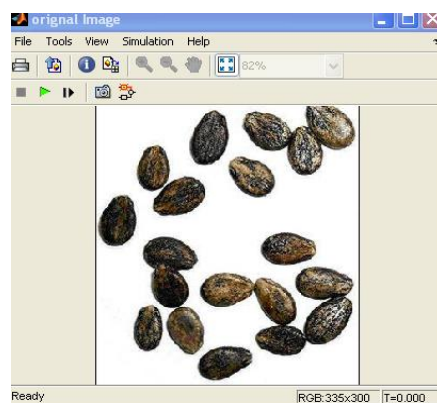


Fig 4.2.1 Original Image of Seed

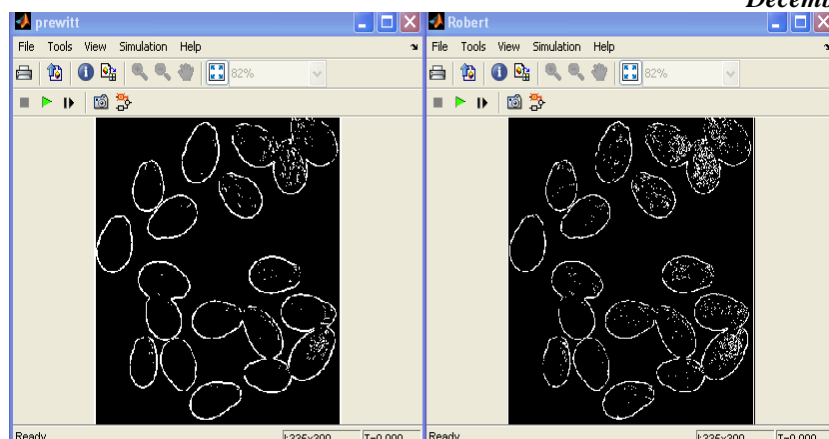
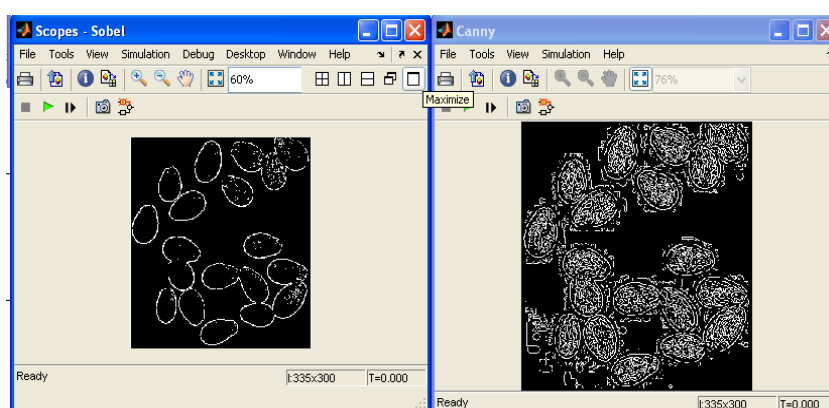


Fig 4.2.2 Edge detection using Prewitt and Robert



4.2.3 Edge detection using Sobel and Canny

V. CONCLUSION

Edge detection is the first step in object recognition process. In this paper, we studied various edge detection techniques like Gradient-based and Laplacian-based techniques. Gradient-based techniques like Prewitt operator have a drawback that it is very sensitive to noise. Here, the size of the kernel filter and coefficients are fixed in advance and cannot be changed for a given image. The Sobel operator is also very sensitive to noise but it has advantage of being simple. Robert does not function properly at the corners and curves where the intensity changes abruptly but it helps in finding correct places of the edge. Canny edge detector is more expensive computationally as compared to Sobel's, Prewitt's and Robert's operator. But Canny edge detector also performs better than all these operators in almost all the scenarios. Evaluation of the images showed that under noisy conditions Canny, Robert, Sobel exhibit better performance, respectively. Canny yielded the best results. This was expected as Canny edge detection accounts for regions in an image. Canny yields thin lines for its edges by using non-maximal suppression. Canny also utilizes hysteresis with thresholding.

REFERENCES

- [1] Nicolaos B. Karayiannis, " Segmentation of Magnetic Resonance Images Using Fuzzy Algorithms for Learning Vector Quantization", IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 18, NO. 2, FEBRUARY 1999.
- [2] Mark A. Horsfield, Rohit Bakshi, Marco Rovaris, Mara A. Rocca, Venkata S. R. Dandamudi, Paola Valsasina, Elda Judica, Fulvio Lucchini, Charles R. G. Guttmann, Maria Pia Sormani, and Massimo Filippi, " Incorporating Domain Knowledge Into the Fuzzy Connectedness Framework: Application to BrainLesion Volume Estimation in Multiple Sclerosis", IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 26, NO. 12, DECEMBER 2007.
- [3] Wenshuo Gao, Lei Yang, Xiaoguang Zhang, Huizhong Liu, " An Improved Sobel Edge Detection", 978-1-4244-5540-9/10/\$26.00 ©2010 IEEE.
- [4] Er. Manpreet Kaur, Ms. Sumeet Kaur, "A New to Edge Detection using Rule Based Fuzzy Logic" ,JGRCS, Volume 2, No. 9, September 2011.
- [5] C.NagaRaju , S.NagaMani, G.rakesh Prasad, S.Sunitha, "Morphological Edge Detection Algorithm based on Multi-Structure Elements of Different Directions",IJICT, Volume 1 No. 1, May 2011.
- [6] K. Sai Deepak, Jayanthi Sivaswamy, "Automatic Assesment of Macular Edema from Color Retinal Images", IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 31, NO. 3, MARCH 2012.
- [7] Hossein Ghayoumi Zadeh, Siamak Janianpour, and Javad Haddadnia, "Recognition and Classifiacation of Cancer cells by using Image Processing and LABVIEW", International Journal of Computer Theory and Engineering, Vol. 5, No. 1, February 2013.

- [8] Krishan Kumar , Rajender Kumar,"Enhancement of Image Segmentation Using Morphological Operations",IJETA, Volume 3, Special Issue 2, January 2013.
- [9] Pinaki Pratim Acharjya, Dibyendu Ghoshal,"Edge Detection with Watershed Algorithm for Digital Image using Fuzzy Logic", International Journal of Scientific & Engineering Research, Volume 4, Issue 7, July-2013.
- [10] Somya Saxena,Sunil Kumar,Vijay Kumar Sharma,"Edge Detection using Soft Computing in Matlab", IJARCSSE,Volome 3,Issue 6,July 2013.
- [11] I.M. Elewa, H.H Soliman and A.A. Alshennawy. "Computer vision Methodology for measurement and Inspection: Metrology in Production area, " ansoura Eng. First conf. Faculty of Eng. Mansoura Univ., March 28-30, pp. 473-444, 1995.
- [12] J. F. Canny. "A computational approach to edge detection". IEEE Trans. Pattern Anal. Machine Intell., vol. PAMI-8, no. 6, pp. 679-697,1986.
- [13] G. Maitre, H. Hugli, F. Tieche and J. P. Amann, "Range Image Segmentation Based on Function Approximation," published at ISPRS90, Zurich, Sept. 1990. [14] A. M. Darwish and A. K. Jain, "A Rule Based Approach for Visual Pattern Inspection ," IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 10, No. 1, pp. 56-68, January 1988.