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Performance Analysis of Edge Detection in Cervical Images Using Fuzzy Logic

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ABSTRACT
Cervical Cancer is a leading Cancer in women in and around the world. In this paper, Fuzzy Edge Detector is proposed and applied on the Cervical Image to detect effectively the edges in the cervical image for diagnosing the cervical cancer in an effective manner. This fuzzy edge detector detects the interior and outlier edges in the image which increases the detection rate in cervical images. It detects both thick and thin edges in the cervical images. The Sobel Edge Detector detects 1458 average edge detection pixels where as the proposed fuzzy Edge Detector detects 2406 average edge detection pixel.
Keywords :- Cervical, Cancer, Edges, Fuzzy, Sobel Edge Detector

I. INTRODUCTION

The cervix is the lower segment of the uterus that associates the uterus to the vagina. The opening of the cervix stays little aside from amid work when it extends to permit the child to go from the uterus to the vagina. Cervical growth happens when cells in the cervix become unpredictably and duplicate unwise. Similarly as with different sorts of disease, it regularly takes years for cervical tumor to create. Initially, ordinary cervical cells change into pre-dangerous cells. Pre-carcinogenic variations from the normal without side effects and if left untreated, they inevitably advance into malignancy. At the point when cervical variations from the normal are distinguished and treated in pre-dangerous stages, cervical disease is preventable. The American Cancer Society evaluated that there are 11,000 new instances of intrusive cervical malignancy analysed in the United States every year and around 4,000 American women bite the dust from the sickness every year. Scientists appraise that non-obtrusive cervical growth is about four times as likely as intrusive cervical distortion. The International Agency for Research on Cancer assesses that almost 380,000 women are gritty to have cervical tumour worldwide every year.

The quantity of cases and number of passing from cervical growth are higher in less created nations where routine screening is not far reaching. Figure 1(a) shows the normal cervical image, which has less number of edges, and Fig. 1(b) shows the abnormal cervical image, which has high number of edges.

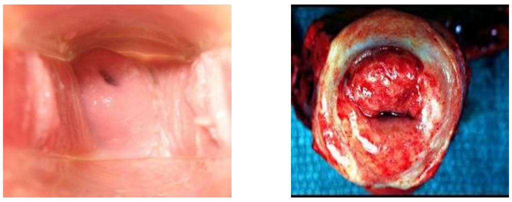


Fig. 1. (a) Normal cervical image (b) Abnormal cervical image.

II. LITERATURE SURVEY

Hayit Greenspan et al. [1] described that an automated analysis system for uterine cervix region which is called as endocervical canal. The proposed scheme was hierarchical. The author used unsupervised modelling at various stages for feature clustering and classification. Using unsupervised clustering enabled an adaptive, image-specific analysis, within the large image archive.

In addition, it eliminated the need for image normalization across the archive and for multi-expert labelling, which is critical for a supervised learning approach. In addition to statistical modelling, the author used, curve evolution tools, with novel energy functional that we derived specifically for the cervigram data. Support Vector Machines (SVM) classifier was trained to extract tumors from the image.

Amir Alush et al. [2] discussed a system for programmed extraction also, division of a class-specific question (or locale) by learning class-specific limits. The final injury district division is acquired utilizing a loopy conviction engendering connected to the watershed circular segment level MRF. The author depicted an area specific mechanized image investigation system for the recognition of pre-carcinogenic and destructive sores of the uterine cervix. Their proposed structure withdraws from past techniques in that we incorporate space specific indicative elements in a probabilistic way utilizing restrictive arbitrary fields.

Horng et al. [3] depicted that cervical malignancy was normal among women everywhere throughout the world. In spite of the fact that contamination with high-hazard sorts of Human Papilloma Virus (HPV) had been recognized as the essential driver of cervical growth, just some of those contaminated go ahead to create cervical growth. Clearly, the movement from HPV disease to growth includes other ecological and host elements. Late population based twin and family concentrates on have exhibited the significance of the inherited part of cervical tumor, connected with hereditary helplessness. Subsequently, Single-Nucleotide Polymorphism (SNP) markers and microsatellites ought to be viewed as hereditary variables for figuring out what mixes of hereditary elements are included in precancerous changes to cervical growth.

Pabitra Mitra et al. [5] depicted a method for outlining a half-and-half-choice emotionally supportive network in delicate figuring worldview for identifying the diverse phases of cervical growth. Hybridization incorporates the development of information based sub-network modules with hereditary calculations (GA's) utilizing unpleasant set hypothesis and the Interactive Dichotomizer 3 (ID3) calculation. Various complex machine learning systems [6] have been created utilizing ANN's, which were further used to comprehend a few complex genuine issues.

III. MATERIALS AND METHODS

A. Materials

In this paper, the cervical images are obtained from Guanacaste dataset [10], which was created in 1997 by National Cancer Institute (NCI) in Guanacaste project and updated in every year. This dataset contains cervical images in various categories as patient with cancer, patient without any abnormal lesions, but later developed cancer at follow-up and healthy persons, who never have the abnormal lesions in cervix area.

B. Methods

In this paper, the edges in the cervical images are detected using Fuzzy logic. The main advantage of the fuzzy logic over the conventional edge detection algorithms are that it will detect both thick as well as thin edges in the cervical images as shown in Fig.2. In this work, Sobel Edge Detection Methodology is compared with Fuzzy Edge Detection Methodology. The sobel edge detector detects only the interior edges in the cervical image, where as fuzzy edge detector detects both interior and exterior edges in the cervical image.

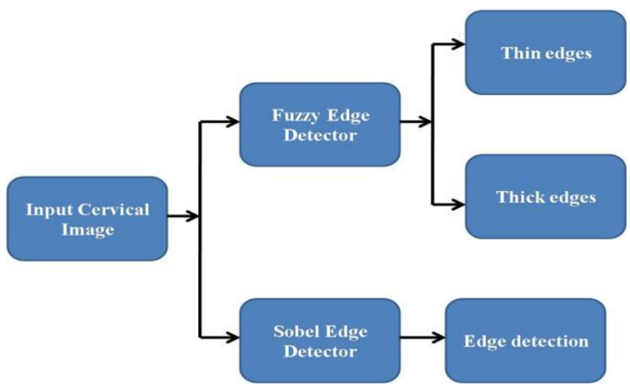


Fig 2 Proposed Edge Detection in Cervical Images

Fuzzy logic is categorized into Mamdani and Sugeno Fuzzy Logic. The Mamdani Fuzzy Logic is used for image analysis where as Sugeno Fuzzy Logic is used for Signal Processing and its Analysis. In this paper, Mamdani Fuzzy Logic is used to obtain the edges in the cervical images. In Mamdani fuzzy logic, four input variables and single output variable is chosen. Hence, there is the possible of 16 rules in mamdani fuzzy logic. These 16 fuzzy rules are applied on each pixel in the cervical image. Fig.3 shows the implementation of fuzzy logic.

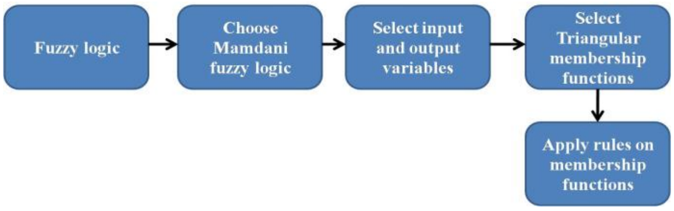


Fig 3 Fuzzy logic implementation

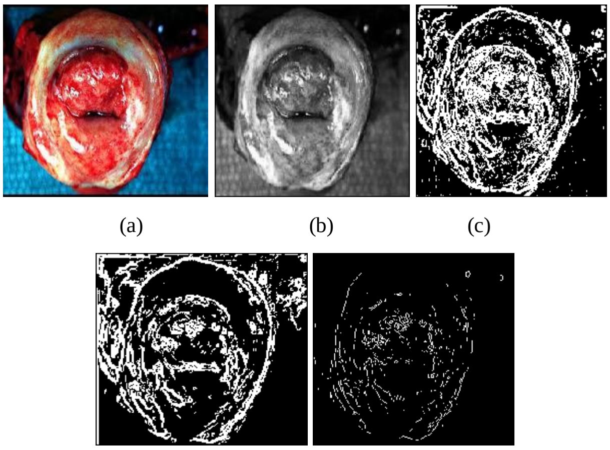
TABLE 1
MAMDANI FUZZY RULES FOR EDGE DETECTION

0	0		0	0	
0	0		0	1	
		NE			E
0	0		0	0	
1	0		1	1	
		E			E
0	1		0	1	
0	0		0	1	
		E			E
0	1		0	1	
1	0		1	1	
		E			E
1	0		1	0	
0	0		0	1	
		E			E
1	0		1	0	
1	0		1	1	
		E			E
1	1		1	1	
0	0		0	1	
		E			E
1	1		1	1	
1	0		1	1	
		E			NE

The mamdani fuzzy rules used in this paper for the detection of edges in cervical image are shown in Table 1.

- The 4^{th} pixel is set to Non-edge when all other three pixels in 2*2 window are belongs to either zero or one.
- The 4^{th} pixel in 2*2 window is set to edge when any one of the three pixels belongs to the inversion of the 4^{th} pixel in 2*2 window.

These rules can be applied on the entire cervical image to detect both thick as well as thin edges. The first iteration produces thick edges which is more or less similar to the conventional sobel edge detection method. The second iteration produces thin edges, which cannot be detected by conventional edge detection methods.

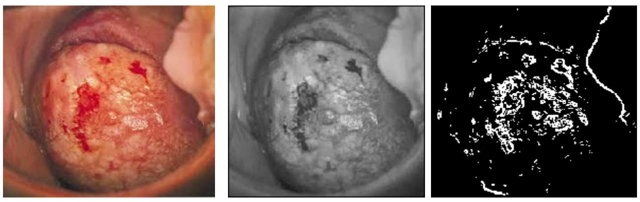


(a) (b) (c)

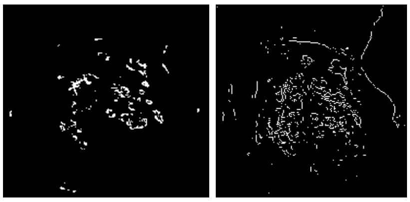
(d) (e)

Fig 4 Severe case (a) Cervical image (b) Grey scale image (c) Thick edges detected image (d) Thin edges detected image (e) Edge detection by Sobel method

Fig.4(a) shows the cervical image in severe cancer affected case, Fig.4(b) shows the grey scale image, Fig.4(c) shows the Thick edges detected image, Fig.4(d) shows the Thin edges detected image and Fig.4(e) shows the Edge detection by sobel method.



(a) *(b)* *(c)*



(d) *(e)*

Fig 5 Moderate case (a) Cervical image (b) Grey scale image (c) Thick edges detected image (d) Thin edges detected image (e) Edges detection by Sobel method

Fig.5(a) shows the cervical image in moderate cancer affected case, Fig.5(b) shows the grey scale image, Fig.5(c) shows the Thick edges detected image, Fig.5(d) shows the Thin edges detected image and Fig.5(e) shows the Edge detection by sobel method.

IV. RESULTS AND DISCUSSION

The edge detection process in abnormal cervical image is more complicated than the normal cervical image. MATLAB R2012b is used in this paper for obtaining simulation results on Pentium i3 Core 2 Duo system with 1GB internal RAM. Table 1 shows the Analysis of Edge detection using Sobel edge detector. The sobel edge detector detects only the thick edges in the cervical images as shown in Table 1. The Sobel edge detection method is applied on different cervical images in both normal and abnormal case of cancer severity.

The conventional sobel edge detection method detected the edges in the cervical images through the detection of abrupt changes in the pixel values of the cervical images in both normal and abnormal cases. Generally, the abnormal cervical images have more number of abnormal patterns in their image regions. The sobel edge detection method detected less number of edges in the abnormal cervical images than the normal cervical images. Another limitation of the sobel edge detection method is that it detected the interior edge pixels in the cervical image which degrades the edge detection process.

TABLE 2
ANALYSIS OF EDGE DETECTION USING SOBEL EDGE DETECTOR

Image Sequence	Sobel Edge Detector
1	312
2	324
3	245
4	267
5	310

In Table 2, cervical image sequence 1, 2 and 5 are belonging to abnormal cervical images which contains more number of abnormal edges. The cervical image sequences 3 and 4 are belonging to normal cervical images which do not contain any abnormal tissue patterns.

Table 3 shows the Analysis of Edge detection using Fuzzy edge detector. The proposed fuzzy edge detector detects both thick as well as thin edges in the cervical images.

TABLE 3
ANALYSIS OF EDGE DETECTION USING FUZZY EDGE DETECTOR

Image Sequence	Fuzzy Edge detector		
	Thick edges	Thin edges	Total edges
1	387	248	635
2	261	101	362
3	263	263	526
4	217	183	400
5	291	192	483

Table 4 shows the comparisons of edge detection in both sobel and fuzzy edge detectors. It is clear from Table 4; the proposed fuzzy based edge detector detects higher number of thick and thin edges in the cervical images than the sobel edge detectors.

The proposed Fuzzy Based Edge Detection method in this paper detected the Internal and External Edge pixels in both normal and abnormal Cervical images. This Fuzzy Edge Detection Method finds the abrupt change in pixel values in abnormal cervical images.

TABLE 4
COMPARISONS OF EDGE DETECTION

Image Sequence	Fuzzy Edge detector	
	Sobel Edge Detector	Fuzzy Edge detector
1	312	635
2	324	362
3	245	526
4	267	400
5	310	483

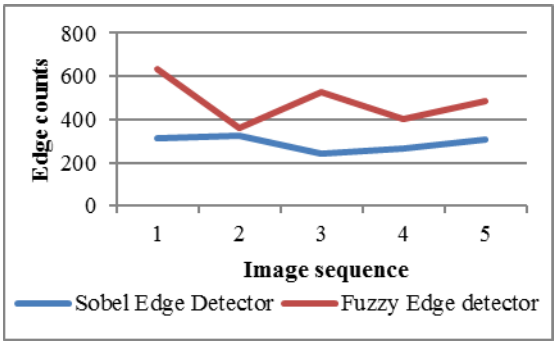


Fig 6. Illustration of edge detection in sobel and fuzzy method

Fig.6 shows the graphical comparisons of the edge detection in both sobel and fuzzy method. Table 5 compares the average edge detection in both sobel and fuzzy edge detection methods. The soble edge detector detects 1458 edge pixels in cervical images as an average result and fuzzy edge detector detects 2406 edge pixels in cervical images as an average result.

TABLE 5
COMPARISONS OF AVERAGE EDGES IN CERVICAL IMAGES

Edge Detectors	Average detected edges
Sobel Edge Detector	1458
Fuzzy Edge detector	2406

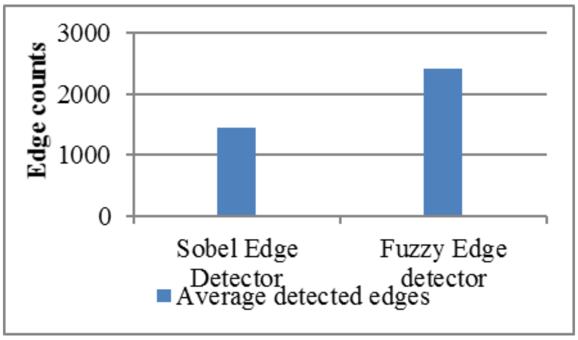


Fig 7. Illustration of edge detection comparisons

Fig.7 shows the graphical comparisons of the total number of edge detection in both conventional sobel and proposed fuzzy method.

V. CONCLUSION

This paper describes proposes fuzzy based edge detection methods on cervical images for detecting the abnormal edges in cancer region. The proposed fuzzy Edge Detection Method among other edge detection methods achieves higher edge detection pixels in the cervical image for both normal and abnormal cases. This fuzzy edge detector detects the interior and outlier edges in the image, which increases the detection rate in cervical images. It detects both thick and thin edges in the cervical images. The Sobel Edge Detector detects 1458 average edge detection pixels where as the proposed Fuzzy Edge Detector detects 2406 average edge detection pixel.

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