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Performance of Standard SOBEL & Fuzzy Operator

Er. Gagandeep Kaur[1], Narinder Singh[2], Lal Singh[3]

Assistant Professor, Dept. of Computer Science, Guru Nanak College, Budhlada, Mansa, Punjab, India[1]

Assistant Professor, Dept. of Computer Science, Guru Nanak College, Budhlada, Mansa, Punjab, India[2]

Assistant Professor, Dept. of Computer Science, Guru Nanak College, Budhlada, Mansa, Punjab, India[3]

ABSTRACT: Edge detection is a technique in image processing for finding the boundaries of objects within images. An image is a combination of pixels according to x and y axis coordinates. It is used for finding the object from a particular region. For extracting and Retrieval of images, firstly coloured images are converted into gray scale images using some filters. Edges are extracted from the gray scale images. Due to Noise some edges are not shown properly. In this paper Sobel operator and fuzzy logic operator are used to extract edges. Sobel operator is used on images only gives binary values. Fuzzy logic operator gives best result because it is used for fractional value and gives sharp edges.

KEYWORDS: Image Processing, SOBEL operator, Fuzzy Operator, Edges.

I. INTRODUCTION

In digital image, the edge is a collection of the pixels. It also refers to the part where the brightness of the image local area changes significantly. The gray profile in this region can generally be seen as a step. That is, in a small buffer area, a gray values rapidly in change. Edge widely exists between objects and backgrounds. The edge of an object is reflected in the change of the gray scale color. Therefore change in variation of the edge neighbors. First order or second-order of equations are used to detect the edge [2]. This method is used as local operator edge detection method. Mainly lines and curves are used in the classification of edges. A single and smooth curve can be partitioned into connected generic curve segments. These segments are qualitatively defined by the tangent function set. A curve partition point (CPP) is a perceptually significant point at which a transition of monotonicity of TF takes place. The curve partition points can always be classified into eight categories.

- Accordingly, the eight categories of GCS are illustrated in Figure 1. The first four categories of GSS are curve segments (CS) which are labeled as CS1 to CS4 and the other four categories of GCS are straight line segments (LS) which are labeled as LSI to LS4.

There are many ways to perform edge detection. However, the majority of different methods may be grouped into two categories [1].

- Gradient: The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image.
- Laplacian: The Laplacian method searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location [11][13].

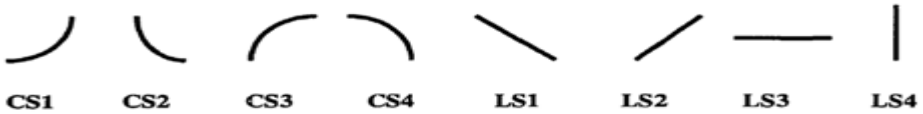

Figure1. The eight categories of generic line segments

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1.1 Sobel operator

SOBEL operator consists of a pair of 3*3 convolution kernel. One kernel is simply the other related by 90 degree. There is a one kernel for each of the two perpendicular situations like vertically and horizontally relative to pixel grid. Kernels pixel grid is shown in Figure 2(a) and Figure. 2(b) [4].

1	0	1
-2	0	2
-1	0	1

Figure 2(a) G(x)

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

Figure 2(b) G(y)

In Standard Sobel operators, for a 3×3 neighborhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors [1]. Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors. Thus for a point on Cartesian grid and its eight neighbors having density values are shown in Figure 3.

a	b	c
d	e	f
g	h	i

Figure 3

The directional derivative estimate vector *G* was defined such as density difference /distance to neighbor. This vector is determined such that the direction of *G* will be given by the unit vector to the approximate neighbor. Note that, the neighbors group into antipodal pairs: (a,i), (b,h), (c,g), (f,d). The vector sum for this gradient estimate:

$$G=(c-g)/R.[1,1]/R+(a-i)/R.[-1,1]/R+(b-h).[0,1]+(f-d).[1,0]$$

Where Value of R is $\sqrt{2}$

$$G=[(c-g-a+i)/2+(f-d), (c-g+a-i)/2+b-h]$$

Here, this vector is multiplied by 2 because of replacing the divide by 2. The resultant formula is given as follows

$$G'=2.G=[(c-g-a+i)+2.(f-d),(c-g+a-i)+2(b-h)]$$

The following weighting functions for x and y components were obtained by using the above vector.
The gradient magnitude is given by this equation[3].

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Typically, an approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

This is much faster to compute. The angle of orientation of the edge giving rise to the spatial gradient is

$$\theta = \arctan(Gy/Gx)$$

Advantages

- It is very simple.
- It detects the edges and their orientation.

Disadvantages

- Sensitive to noise.
- Inaccurate method.

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II. INTRODUCTION TO FUZZY LOGIC SYSTEM

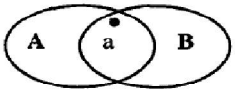
Fuzzy logic was first introduced in the 1965 as a new way to represent vagueness in everyday life [12]. The definition of fuzzy logic as a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth values between "completely true" and "completely false". By this definition, fuzzy logic departs from classical two-valued set logic

- Between fuzzy logic and fuzzy subset theory, there is a strong relationship which is similar to the relationship between classical logic [5][6] and the concept of a subset. In classic[8] set (or subset) theory; a subset U of a set S can be defined as a set of ordered pairs. The statement "**A** is in **U**" is true or false that is determined by finding the ordered pair whose first element is a. The statement is true if the second element of the order pair is 1, and the statement is false if it is O. In classic set (or subset) theory, the logical operations such as AND, and OR are listed below [9][10].

- Intersection and logical "AND" are defined as following: For two sets **A**, and **B**

$A \cap B$

$a \in A$ "*AND*" $a \in B$



characteristic function for $A \cap B$

$U_{A \cap B}(a) = 0$ if $a \notin A$ *AND* $a \notin B$

$U_{A \cap B}(a) = 0$ if $a \notin A$ *AND* $a \in B$

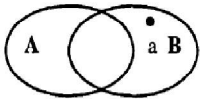
$U_{A \cap B}(a) = 0$ if $a \in A$ *AND* $a \notin B$

$U_{A \cap B}(a) = 1$ if $a \in A$ *AND* $a \in B$

$U_{A \cap B}(a) = \min (U_A(a), U_B(a))$

Intersection and "**AND**"

$A \cup B$



$a \in A$ "*OR*" $a \in B$

characteristic function for $A \cup B$

$U_{A \cup B}(a) = \max (U_A(a), U_B(a))$

Union and Logical "**OR**"

In fuzzy logic "min" and "max" operators can be used to describe intersection and logical "AND", union and logical "OR", difference , and complement as follows.

III. FUZZY LOGIC OPERATIONS

fuzzy logic can give the degree of truth of the statement "person C is tall". The meaning of "person C is tall" is clear. If another fuzzy subset of set "people" is added, cal1 this subset "Old", which is defined by the membership function then one can compute some values for some statements such as "person C is ta11 and C is old"[7].

Old (p) = 0, if age (p) < 15 year

Old (p) = (age (p) - 15 year) / 50 year if 15 year ≤age (p) ≤ 65 year

Old (p) = 1, if age (p) > 65 year

The standard definitions of operations in Fuzzy Logic are [14]:

Truth(x AND y) = minimum (Truth(x), Truth(y)),

Truth(x OR y) = maximum (Truth(x), Truth(y)),

Truth (N0T x) = 1 .O - Truth(x).

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Persons	Height (cm)	Age (year)	Tall (degree)	Old (degree)	AND (tall,old)	OR (tall,old)	NOT Tall	NOT old
A	115	10	0.000	0.000	0.000	0.000	1.000	1.000
B	125	11	0.063	0.000	0.000	0.063	1.000	0.937
C	142	16	0.213	0.020	0.020	0.213	0.980	0.787
D	155	42	0.436	0.540	0.436	0.540	0.564	0.460
E	176	68	0.700	1.000	0.700	1.000	0.300	0.000
F	194	28	0.925	0.260	0.260	0.925	0.740	0.075
G	183	52	0.786	0.740	0.740	0.786	0.260	0.214
H	210	35	1.000	0.400	0.400	1.000	0.600	0.000

Table1. Definition of eight curve partition points and their associated grouping rules.

IV. PROBLEM STATEMENT

4.1 PROBLEM DEFINITION

Traditional edge detection techniques, such as Robert operator, Sobel operator, Laplacian of Gaussian operator are widely used. Most of the existing techniques are either very sensitive to noise and do not give satisfactory results in low contrast areas. A fuzzy theory based Edge Detector avoids these problems and is a better method for edge information detection and noise filtering than the traditional methods. Edge detection using fuzzy logic provides an alternative approach to detect edges. First-order linear filters are mostly applied for edge detection in digital images. Nevertheless they don't allow good results to be obtained from images where the contrast varies a lot, due to non-uniform lighting [12]. But in this research fuzzy inference system is applied for edge detection to improve the performance.First, an input image is processed in different non- successive linear filtering stages. The gray level in each pixel of the resulting image is then obtained by applying the FIS system to the corresponding values in the output images of the linear operators, in the same pixel. During input image pre-processing, three kinds of linear filters are applied to it: Sobel operators, used to estimate its derivatives in horizontal and vertical directions (hDH and hDV filters), a low-pass (mean) filter and a high-pass filter. The developed fuzzy system's purpose is to determine if pixel evaluated is or is not present in one of image's edges.

4.2 Objectives

The objectives of Edge detection Techniques using Fuzzy Logic are-

- To detect the edges in all type of images like JPEG, GIF, Gray scale images.
- To detect the proper edges without any uncertainty.
- To detect the edges which are thick, dark and free from noise.

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V. OUTPUT SCREEN

When the input is taken as a image which is selected from the desired folder in my computer.

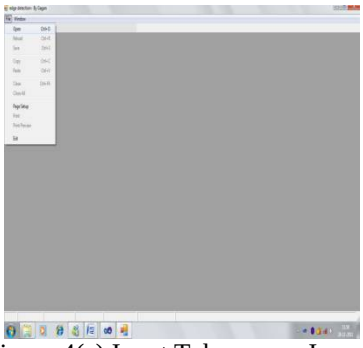
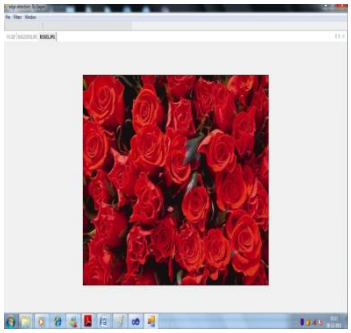
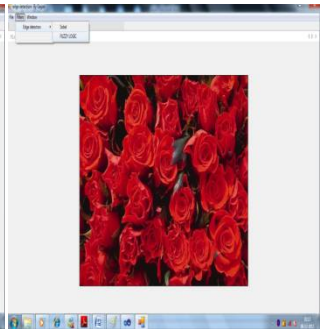


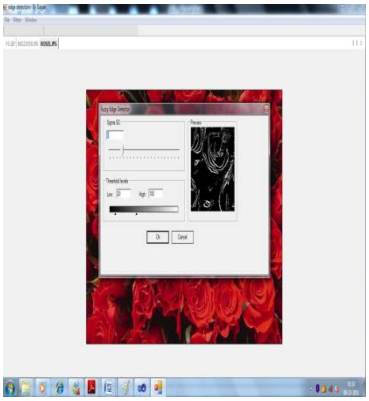
Figure 4(a) Input Taken as an Image



4(b) Input is original image



4(c) Apply Fuzzy Logic Technique



4(d) Fuzzy logic filter is applied

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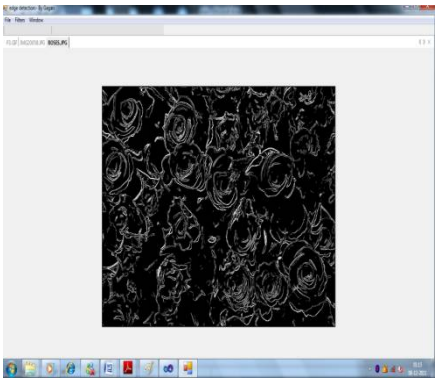
Now Edges are detected with fuzzy logic system. We can see that the images with fuzzy logic edge detection creates less noise as compared to sobel operator

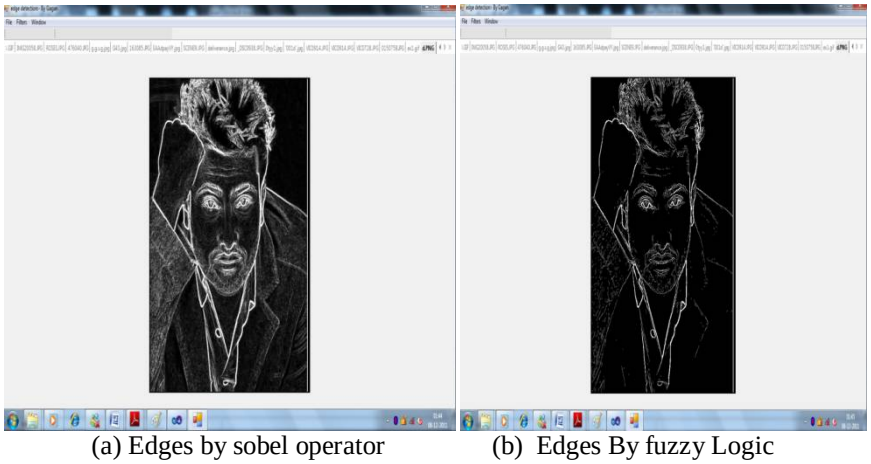


4(e)Gray scale images using Fuzzy Logic Operator

IV. RESULTS

This Algorithm is implemented using visual basic c# in .NET Framework 4.0. A lot of experiments are taken for edge detection using sobel operator and fuzzy logic operator.. This is shown by comparison of fuzzy logic system with sobel operator in pictures on next pages.

More Results: Comparison of all Sobel operator images with Fuzzy operator images is shown below :



(a) Edges by sobel operator (b) Edges By fuzzy Logic

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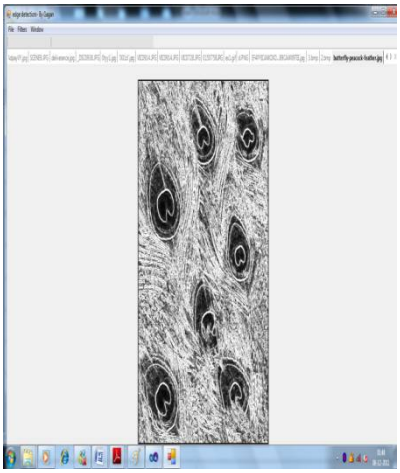
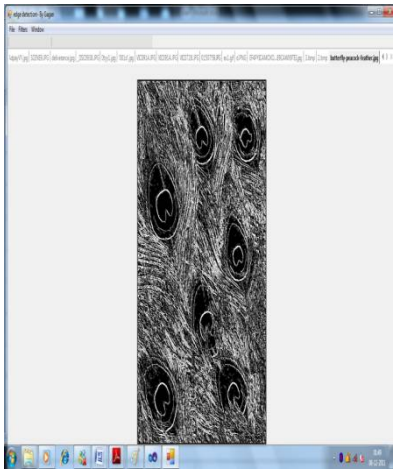


(c) Edges detected by SOBEL operator



(d) Edges detected by fuzzy logic

V. CONCLUSION AND FUTURE WORK

In this paper, a fuzzy based new edge detection algorithm is proposed. Based on the primary edge detection methods, gradient and standard deviation computed at each pixel, and are used as fuzzy system input. The fuzzy system includes appropriate defined membership function and fuzzy rules, decide about pixel classification as edge or non-edge. Experimental results show the higher quality and superiority of the extracted edges compared to the SOBEL operator. In the proposed algorithm, to achieve good result, some parameters and thresholds are experimentally set. Automatically determining these values needs to further researches. Improving fuzzy system performance by the ways such as using different kind of input, different fuzzy membership functions and rules also need to be investigated in future works.

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BIOGRAPHY

Er. Gagandeep Kaur is an Assistant Professor in Computer Science Department, Guru Nanak College Budhlada . She received Master of Technology (M.Tech) degree in 2012 from YCOE Campus, Punjabi University Patiala, India. Her research interest is in Digital Image Processing.