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Reducing SSIM (Structural Similarity Index Measure) Using Improved Edge Detection Technique on Grey Scale Images

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Abstract: An edge is sharp change in intensity of an image But, since the overall goal is to locate edges in the real world via an image, the term edge detection is commonly used. An edge is not a physical entity, just like a shadow. It is where the picture ends and the wall starts, where the vertical and the horizontal surfaces of an object meet. If there were sensor with infinitely small footprints and zero-width point spread functions, an edge would be recorded between pixels within in an image. In reality, what appears to be an edge from the distance may even contain other edges when looked close-up. The edge between a forest and a road in an aerial photo may not look like an edge any more in a image taken on the ground. In our proposed algorithm we have taken an image and then we have apply our proposed algorithm. In the first step the image is taken of size say mxn , and then we apply Gx operator on it and save the result in the G1 variable, again we apply Gy operator on it and save the result in the G2 variable. We compare the value of G1 and G2 , if the value of G1 is larger than G2, that means the image has more horizontal edges and if the value of the G2 is larger than G1 , then the image has more vertical edges. In the sobel operator the problem is that, we calculate the magnitude without caring of horizontal and vertical edges because of that the sobel operator gives us poor results. In our proposed algorithm if G1 is greater than G2 , then we take square of G1 and divide the result with m(length of image), to make the sharp horizontal edges
Keywords: SSIM, TIFF, MATLAB

I. INTRODUCTION

A digital image is a representation of a two-dimensional image as a finite set of digital values. In image processing, the digitization process includes sampling and quantization of continuous data. The sampling process samples the intensity of the continuous-tone image, such as a monochrome, color or multi-spectrum image, at specific locations on a discrete grid. The grid defines the sampling resolution. The quantization process converts the continuous or analog values of intensity brightness into discrete data, which corresponds to the digital brightness value of each sample, ranging from black, through the grays, to white. A digitized sample is referred to as a picture element, or pixel. The digital image contains a fixed number of rows and columns of pixels. Pixels are like little tiles holding quantized values that represent the brightness at the points of the image. Pixels are parameterized by position, intensity and time. Typically, the pixels are stored in computer memory as a raster image or raster map, a two-dimensional array of small integers. Image is stored in numerical form which can be manipulated by a computer.

II. TYPES OF EDGES

All edges are locally directional. Therefore, the goal in edge detection is to find out what occurred perpendicular to an edge. The following is a list of commonly found edges.

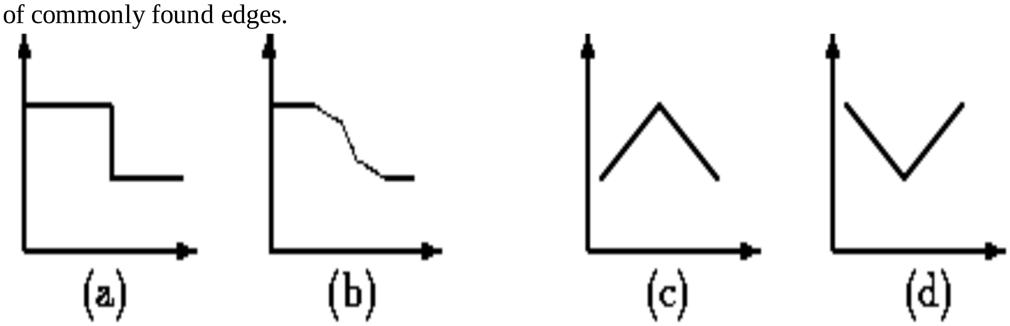


Fig. 1.1: Shows types of Edges (a) Sharp step (b) Gradual step (c) Roof (d) Trough

A Sharp Step, as shown in Figure 1.1(a), is an idealization of an edge. Since an image is always band limited, this type of graph cannot ever occur. A Gradual Step, as shown in Figure 1.1(b), is very similar to a Sharp Step, but it has been smoothed out. The change in intensity is not as quick or sharp. A Roof, as show in Figure 1.1(c), is different than the first two edges. The derivative of this edge is discontinuous. A Roof can have a variety of sharpness, widths, and spatial extents. The Trough, also shown in Figure 1.1(d), is the inverse of a Roof. Edge detection is very useful in a number of contexts. Edges characterize object boundaries and are, therefore, useful for segmentation, registration, and identification of objects in scenes.

III. SOBEL OPERATOR

The operator consists of a pair of 3×3 convolution kernels as shown in Figure 1.2.a. One kernel is simply the other rotated by 90°.

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

Gx

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

Gy

Fig. 1.2.a Operator consists of a pair of 3×3 convolution kernels

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

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

Typically, an approximate magnitude is computed using:

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

IV. PROPOSED ALGORITHM

According to our proposed technique, the Sobel operator is modified according to following formula in Fig 1.2

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

Gx

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

Gy

Fig 1.2: Shown the modified calculation of Sobel Operator

The following are steps of the algorithm

1) Input the gray scale image of size mxn.
2) Repeat step 3 to 8 for the entire image
3) Apply 3x3 Gx operator on the image portion of 3x3 and result is stored in a variable named G1.
4) Apply 3x3 Gy operator on the image portion of 3x3 and result is stored in a variable named G2.
5) If (G1>G2) then
    G1=(G1 * G1)/m
    Else
    G2=(G2 * G2)/n

Where m is length of image and n is the width of the image.

6) Then we calculate the magnitude as given

$$|G| = \sqrt{G_1{}^2 + G_2{}^2}$$

7) At this step we compare the value of G with tolerance value lies between 45 and 60

8) if(G<45)

```
{
  outputImge[i][j]=255;
}
else
{
outputImge[i][j]=0;
}
```

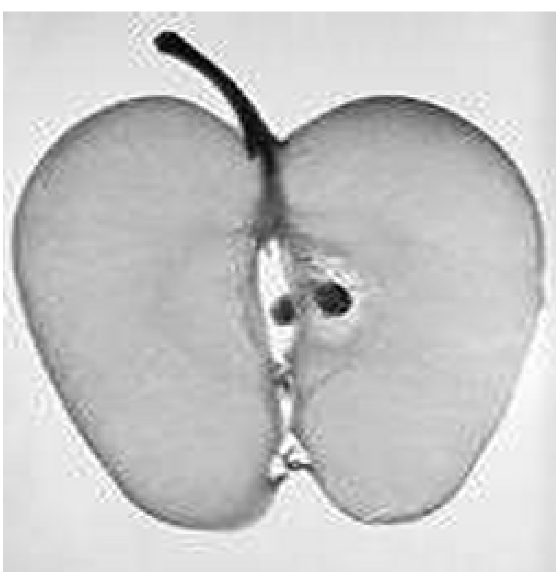
A. Explanation of the Algorithm

In our proposed algorithm we have taken an image and then we have apply our proposed algorithm. In the first step the image is taken of size say mxn , and then we apply Gx operator on it and save the result in the G1 variable, again we apply Gy operator on it and save the result in the G2 variable. We compare the value of G1 and G2 , if the value of G1 is larger than G2, that means the image has more horizontal edges and if the value of the G2 is larger than G1 , then the image has more vertical edges. In the sobel operator the problem is that, we calculate the magnitude without caring of horizontal and vertical edges because of that the sobel operator gives us poor results. In our proposed algorithm if G1 is greater than G2 , then we take square of G1 and divide the result with m(length of image), to make the sharp horizontal edges. Similarly if G2 is greater than G1 , then we take square of G2 and divide the result with n(breath of image), to make the sharp vertical edges. The purpose of doing this is to make both the horizontal and vertical sharp so that when we calculate the magnitude G, we will obtain better results than existing algorithms(sobel, prewitt etc.)

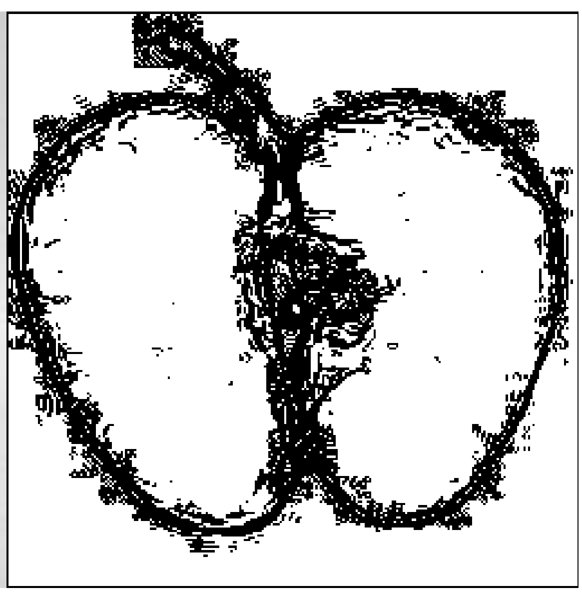
B. The Structural Similarity Index

The Structural Similarity Index (SSIM) is a perceptual metric that quantifies image quality degradation caused by processing such as data compression or by losses in data transmission. It is a full reference metric that requires two images from the same image capture- a reference image and a processed image.

V. RESULTS



Original Image



Sobel operator result

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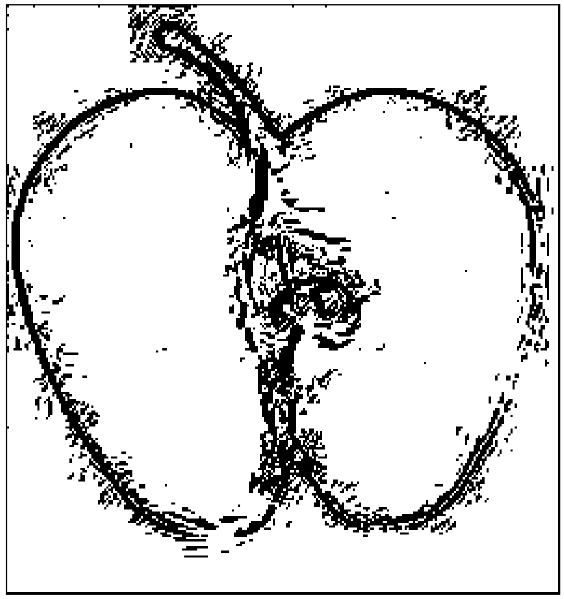

Proposed algorithm result

Fig 1.3: Implementation of Sobel Operator and Proposed Algorithm

Table 1.1: Performance Analyses of Sobel Operator and Proposed Algorithm Based on SSIM Values

Parameter	Sobel Operator	Proposed Algorithm
The Structural Similarity Index	0.1409	0.2247

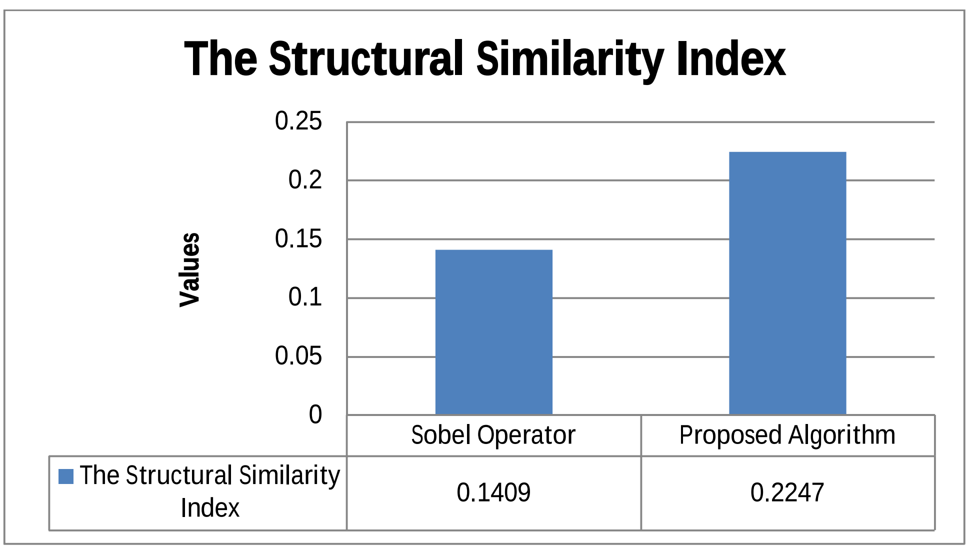

Fig. 1.4: Performance of Sobel Operator and Proposed Algorithm on SSIM values

VI. DISCUSSION

The goal of the edge detection process in a digital image is to determine the frontiers of all represented objects, based on automatic processing of the color or gray level information in each present pixel. First-order linear filters are most widely applied to edge detection in digital images. But they do not give good results in images where the contrast varies a lot, due to non-uniform lighting, as it happens during acquisition of most part of natural images. In our proposed algorithm edge detection provides better results than that of other traditional edge detectors. 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. In our algorithm the output image, the edges are sharper as compared to other methods. So our algorithm is more accurate as compared to other methods.

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VII. CONCLUSION

In our research, we have implemented a Proposed technique which has been performed on different images. After observing the result and analysis we have found that the technique that we have implemented has given us a better enhanced result in comparison with other predefined operator.

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