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An Efficient Image Sharpening Filter for Enhancing Edge Detection Techniques for 2D, High Definition and Linearly Blurred Images

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Abstract— The edge detectors are widely used in computer vision to locate sharp intensity changes and to find object boundaries in an image. Image Edge detection significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. Since edge detection is in the forefront of image processing for object detection, it is crucial to have a good understanding of edge detection algorithms. The construction of a pre-processing filtering tool for edge detection and segmentation tasks is still a challenging matter. In this paper the revision of edge detectors are done to improve their detection accuracy. This work proposes an edge sharpening filter to sharpen the edges of an image prior to detection and then apply the edge detectors for the better results. The difference in the output can be observed by comparing the results of edge detection under normal and filtered conditions.

Keywords-Edge detection,Canny edge detection technique improvement, Image Sharpening Filter,Comparative analysis of image with proposed Filter and 2D FIR Filter

I. INTRODUCTION

Edges are boundaries between different textures. Edge may also be defined as discontinuities in image intensity from one pixel to another. The edges for an image are always the important characteristics that offer an indication for a higher frequency. Detection of edges for an image may help for image segmentation, data compression, and also help for well matching, such as image reconstruction and so on. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges. Not all edges involve a step change in intensity. Effects such as refraction or poor focus can result in objects with boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases. So, there are problems of false edge detection, missing true edges, edge localization, high computational time and problems due to noise etc. Therefore, the objective is to enhance the edges using a preprocessing step before detecting the edges using the proposed filter and comparing the results obtained using 2D FIR filter in different conditions.

II. EDGE DETECTION TECHNIQUES

A. Sobel

First Standard Sobel operators, for a 3×3 neighbourhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors [27, 36]. 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 neighbours having density values as shown:

A_0	A_1	A_2
A_3	A_4	A_5
A_6	A_7	A_8

Table 1: Cartesian grid for orthogonal vectors

Note that, the neighbours group into antipodal pairs: (A_0, A_8), (A_2, A_6), (A_1, A_7), (A_3, A_5).

The vector sum for this gradient estimate:

$$G = \frac{(A2 - A6)}{R} \cdot \frac{[1,1]}{R} + \frac{(A0 - A8)}{R} \cdot \frac{[-1,1]}{R} + \big((A1 - A7)\big).[0,1] + ((A3 - A5).[1,0] \quad (1)$$

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The operator consists of a pair of 3×3 convolution kernels as shown in table 2. One kernel is simply the other rotated by 90°.

Table 2: Masks used by Sobel operator

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

Gx

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

Gy

B. Canny Operator

The Canny operator edge detection is to search for the partial maximum value of image gradient. The gradient is counted by the derivative of Gauss filter. The Canny operator uses two thresholds to detect strong edge and Weak edge respectively. The gradient magnitude and direction is calculated by using first order finite differences. The Canny edge detection algorithm is known to many as the optimal edge detector.

Table.3: Masks used for canny operator

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

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

III. CREATION OF AN IMAGE SHARPENER

In this paper the proposed work shown is to enhance the performance of edge detectors by usage of an image sharpening filter. The edge detection capability of an edge detector can be improved by enhancing the boundaries separating a particular area of an input image having abrupt intensity changes at different borders. To emphasize the areas of an image sharpening is required and this sharpening is achieved by creation of an image sharpener described in the equation (2) given below:

$$m(y_1, y_2) = \frac{m_b(y_1, y_2)}{\sum_{y_1} . \sum_{y_2} m_b} \qquad (2)$$

A. Image Sharpner Using Proposed Filter

For values of h_v take linear matrix of 3x3. (The purpose of taking linear matrix is to have good results for images that are blurred equally from all parts as in table 4.

Table 4: Linear matrix

1/y	1/y	1/y
1/y	1/y	1/y
1/y	1/y	1/y

y = 1, 2, 3……..etc.

- Now blur the image by multiply the input image by $m(y_1, y_2)$ (next steps works for linear blurred image but not for randomly blurred image.)
- Now take a mask with highest weight age at the center as shown in Table 5.

Table 5: Mask used for sharpening

-p	-p	-p
-p	+q	-p
-p	-p	-p

Where p > q

- These masks are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one for each of the two perpendicular orientations.
- Now apply the mask on the blurred image and add it with input taken image.
- The previous step creates a sharper image (by edge sharpener algorithm) and the sharpened image is then applied to an edge detector i.e. canny edge detector for improved results.

B. Image Sharpner Using 2D FIR Filter

To sharpen a color image, there is a need to make the luma intensity transitions more acute, while preserving the color information of the image. To do this, convert an R'G'B' image into the Y Cb Cr color space and apply a high pass filter to the luma portion of the image only. Then, transform the image back to the R'G'B' color space to view the results. To blur an image, apply a low pass filter to the luma portion of the image. This example shows how to use the 2D FIR Filter block to sharpen an image.

IV. RESULTS

The improvement in edge detection works better for a high definition and linearly blurred image and can be checked by taking the “title” mentioned images. The improvement can be checked for different edge detectors and the results are shown in Figure 4.1 as:

Figure 1: High Definition image as test image

A. Improvement in Sobel Edge Detection

Figure 2: Sobel method

Figure 3: Improvement in Sobel method using 2D FIR filter

Figure 4: Improved Sobel method using designed filter

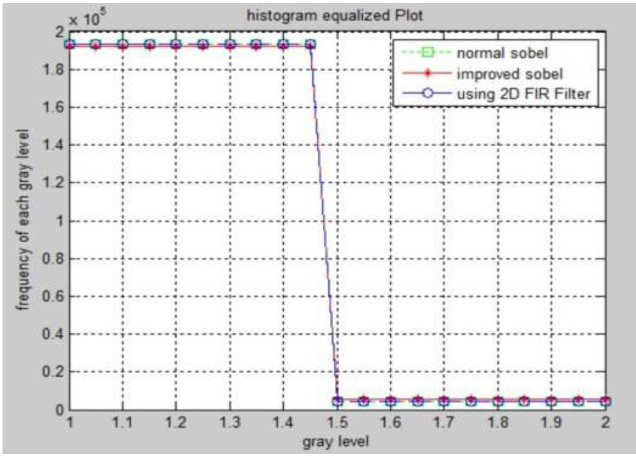

Figure 5: Comparative analysis for all three methods, namely Sobel process, Sobel process using 2D FIR filter and Sobel process using created filter.

B. Improvement In Canny Edge Detection

Figure 6: Canny method

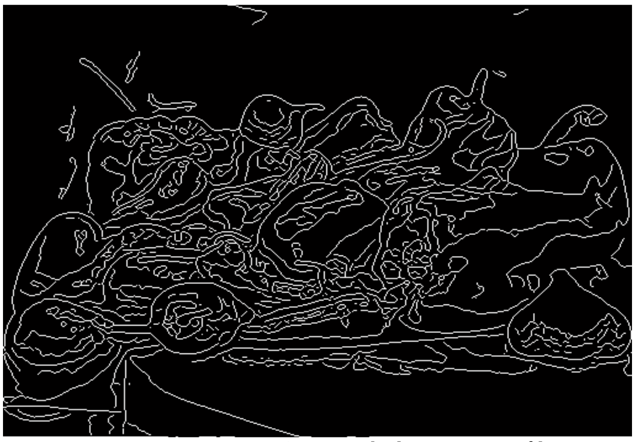

Figure 7: Improvement in Canny method using 2D FIR filter

Figure 8: Improved Canny method using designed filter

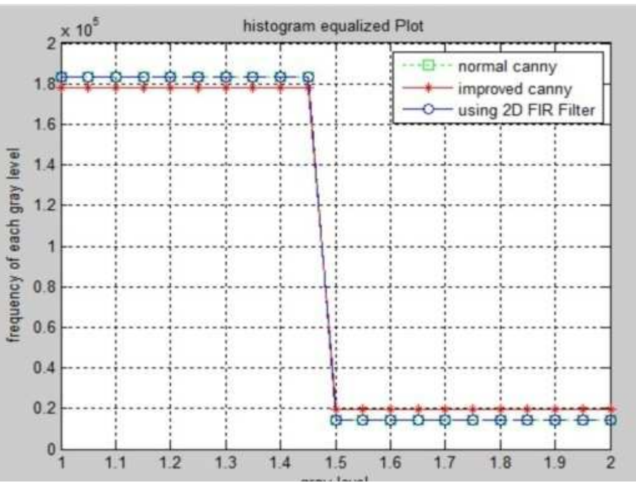

Figure 9: Comparative analysis for all three methods, namely Canny process, Canny process using 2D FIR filter and Canny process using created filter.

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