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# HYBRID FILTER OF SOBEL AND PREWITT

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**Abstract:** Chest problems such as heart failure, lung cancer, lung tuberculosis etc. are often detected by doctors by carefully analyzing the Chest X-Ray images (CXR) and while doing the same they may have to go through the reports of large number of patients which is a tedious process and also time consuming. In order to overcome this problem an automated system known as CAD(computer aided diagnosis) has been adopted where in the suspected areas on the x-ray reports are marked and sent to the doctors for further analysis[3]. But the main drawback of this system is that nodules hidden behind rib bones are not detected which leads to lack of proper information. To avoid this problem the rib cage of different X-ray images have to be suppressed so that nodules hidden behind the ribs are clearly seen and only those images containing nodules are sent to the doctors while the ones without any are rejected by the system[5] .

Furthermore, to suppress the rib cage, first edges of the ribs have to be detected and to achieve this we have proposed a hybrid filter which is the combination of Prewitt and Sobel digital filters.

**Keywords:** Kernels, hybrid, detection, pixels

## 1. Introduction:

### 1.1 Gradient Operators:

Required information is extracted from the images using image gradient and these are formed from the original images (generally by convolving with filters). A gradient in the xdirection measures the horizontal change in the intensity and a gradient in the y-direction measures vertical change in the intensity[4]. Grey pixels have small gradient whereas black or white pixels have large gradient. Gradient images are most commonly used in edge detection. After computation of gradient images, pixels having large gradient values become possible edge pixels and the traced edges are in the direction which is perpendicular to the gradient direction. Prewitt and Sobel filters are one of the types.

### 1.2 Prewitt and Sobel filters:

These filters are the type of operators which are used in image processing for the detection of edges. At each point, these operators calculate the difference between the pixel intensity values and wherever the difference is large, that particular pixel is detected as an edge.

The Sobel operator does the approximation of the gradient by using masks of rows and columns which in turn results in the approximation of the first derivative in every direction. The masks used in Sobel edge detection method find edges in both horizontal and vertical directions and then this information is combined into two matrices i.e., magnitude and direction.

The Prewitt edge detection is proposed by Prewitt in 1970 (Rafael C.Gonzalez [1].The Prewitt operator is almost the same as that of the Sobel, but with different mask coefficients.

## 2. Formulation:

### 2.1 3*3 kernels for Sobel

$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \qquad \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

Horizontal edge (Gx) Vertical edge (Gy)

These masks are individually convolved with the image. At every pixel location we will have two numbers now i.e., s1 and s2 where s1 is the result from vertical edge mask, and s2 is the result from horizontal edge mask. These numbers are used for the computation of two matrices, magnitude edge and direction edge which is stated as follows:

Magnitude Edge=$\sqrt{(s1^2+s2^2)}$
Direction Edge=$\tan^{-1}(s1/s2)$

**2.2 3*3 kernels for Prewitt:**

$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \qquad \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

Horizontal edge (Gx) Vertical edge (G

These masks are individually convolved with the image. At every pixel location we will have two numbers now i.e., s1 and s2 where s1 is the result from vertical edge mask, and s2 is the result from horizontal edge mask. These numbers are used for the computation of two matrices, magnitude edge and direction edge which is stated as follows [2]:

Magnitude Edge=$\sqrt{(s1^2+s2^2)}$
Direction Edge=$\tan^{-1}$ (s1/s2)

## 3. Hybrid Filters:

In computer vision and image processing, the essential image characteristics are determined by edge structures which form the boundaries of object surfaces. Hence edge detection is considered as the core feature extraction in digital image applications and object recognition. The hybrid filters are designed by convolving the Gx (gradient x direction) mask of one or more filters with Gy (gradient y direction) mask of one or more other filters. In this paper the proposed hybrid edge detector combines the advantages of Sobel and Prewitt edge detectors to perform edge detection while eliminating their limitations. Simulation results show that the proposed hybrid edge detection method is able to effectively and consistently produce better edge features even in noisy images. Compared to the other two edge detection techniques, the hybrid edge detector has shown its dominance by returning specific edges with less noise.

## 4. Calculation of Gradient Magnitude and Gradient Direction

Consider the following example in which Prewitt operator is used

$$\text{Let A=} \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$$

A = pixel values of the image

$$Gx = \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} *A$$

$$Gy = \begin{pmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} *A$$

Where

Gx = [(c-a)/2 + (f-d)/2 + (i-g)/2]/3

Gy = [(g-a)/2 + (h-b)/2 + (i-c)/2]/3

The results obtained can be combined to get gradient magnitude given by
G =√ (Gx2 + Gy2)

Similarly resultant gradient direction is given by
θ=arctan (Gy/Gx)

Similarly it can be calculated for Sobel operator

## 5. Experimental Results and Observation:

Here Sobel and Prewitt edge filters and their different hybrid combinations are applied on the image using MATLAB 2013 and the outputs are compared and observed.

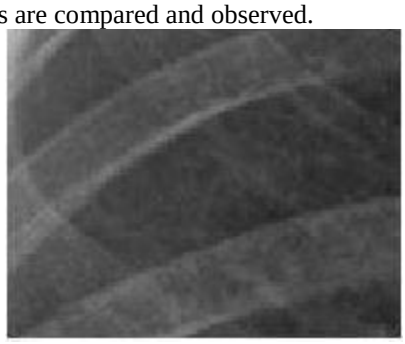

Fig1: Original Image

Fig2: Prewitt

Fig3: Sobel

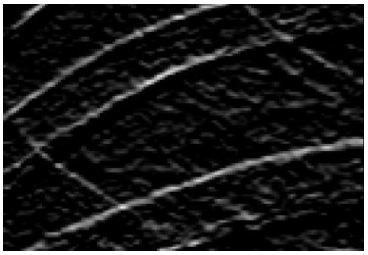

Fig4: SGy+PGy

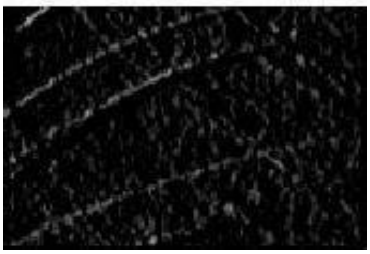

Fig5: SGx+PGx

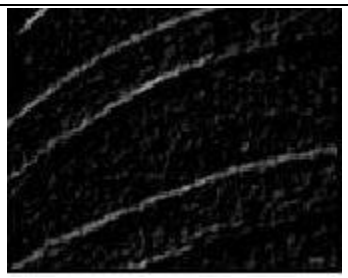

Fig6: SGx+PGy

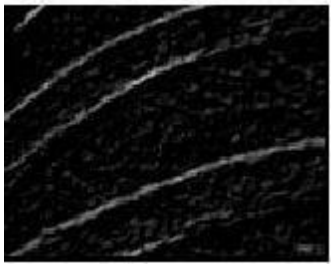

Fig7: SGy+PGx

Similarly, the proposed hybrid filter can also be applied on the following images.

Example 1: Image of rice

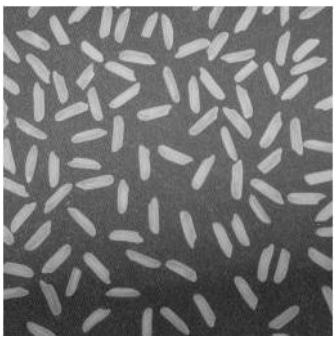

Fig7: Original Image

Fig8: SGy+PGy

Fig9: SGx+PGx

Fig10: SGx+PGy

Fig11: SGy+PGx

Example 2: Image of Lenna

Fig12: Original Image

Fig13: SGy+PGy

Fig14: SGx+PGx

Fig15: SGx+PGy

Fig16: SGy+PGx

## 6. Conclusion:

For the above taken chest image the Sobel and Prewitt filters provide a better result but they do not give better output in all environmental conditions as it is not sensitive and most of the information is lost as only large gradient edges are detected. Edge detection using hybrid filters involves simple steps and gives a considerably better output when compared to Sobel, Prewitt filters under all conditions as it highlights the required edge and also retains the required information in the image.

Out of the above four hybrid filters we can observe that the hybrid filter formed by combination of only Gy mask of both Sobel and Prewitt filter gives a better output as it reduces noise as well as detects the edge dominantly.

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