International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Analysis of Edge Detection Techniques for Complex Background Images

Sheffali Bamba

Punjab Technical University, Department of Computer Science & Engineering, Jalandhar, India

Abstract: ***This paper presents a review on different colour based edge detection techniques. Edge detection has found to be most important step in many critical vision applications. It actually results in the black and white (binary) image where each object is differentiate by lines (either black or white). Edges are basically the area in the image where sharp changes exist. It has been found that the most of the existing techniques has neglected the use of colours while detecting the edges but in many applications a region can be categorised based on the colour. This paper has shown that the most of the existing techniques fails in case of images with complex background.***

Keywords: Edge detection, PCA, Hue, Morphological operations

1. Introduction

Edges are important confined changes of intensity in a digital image. There is a set of curled line up segments identified as edges. It is used in picture segmentation, object detection, information hiding, image coding and so on. Thus apply an edge detection algorithm to an image may ease the total of data to be processed and may sort out information that possibly will be regard as less related while preserving the main structural properties of an digital image. If edge detection step be successful, the consequent task of interpreting the information contents in original image may be easy.

A. PCA Transformation (principal component analysis)

PCA is a linear transformation that removes the connection between the elements of an arbitrary vector, it can be used in colour edge detection with low-computational difficulty.

B. Edge detection for first principal component

Image colour reduction, the three colour components are dense into one containing a main component of information.

Figure B: Edge detection for the first principal component (adaptive from [1])
(a)Input image (b) PCA (c) Edge detection of PCA

C. Hue Factor

A hue refers to a pure colour. Hue is one of the main properties of a **colour.** Generally, colours with the similar hue are distinguished with adjectives referring to their lightness and/or colourfulness, such as with "light blue", "vivid blue". HSV (Human Visual System) - Cylindrical-coordinate representations of points in an RGB colour model.

D. Edge detection for hue component

From colour image to grey-scale image, leads to the outcome that a few edges are missed. Mainly of the missing edges consequence from hue changes. As a result, we can present a superior edge detection illustration for colour image once the problem of edge detection of hue component is solved.

Figure D: Edge detection for hue component (adaptive from [1])
(a) Input Image (b) Hue component (c) Edge detection for the Hue component

E. Edge Fusion

Fusion is the process of combine significant information from two or more images into a particular image. The consequential image will be more useful than any of the input images.

F. Morphological Thinning

Thinning is a morphological process that is used to eliminate selected foreground pixels from binary images. It is generally used to tidy up the output of edge detectors by reducing all lines to particular pixel thickness. Thinning is usually only applied to binary images, and produces an additional binary image as output. To eliminate unnecessary points on the edges in an image.

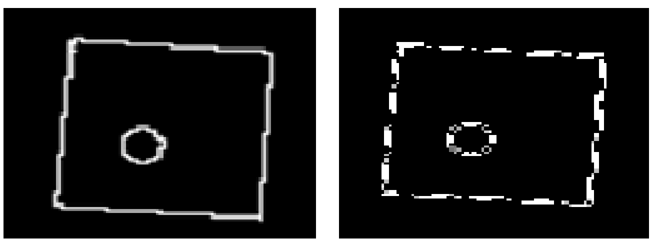

Figure F: Conversion of binary image into output image using thinning (adaptive from [14])

G. True colour

True colour supports 24-bit for three RGB colour. It provides a technique of represent and store graphical-image information in an RGB colour space such that a very huge number of colours, shades, and hues can be displayed in a digital image, such as in high-class photographic images or complex graphics. Generally, true colour is defined to mean at least 256 shades of red, green, and blue.

H. Colour edge detection based on the fusion of hue component and principal component analysis

For gaining more probable outcome for images having true colour than RGB and grey scale images. Here initial the input image is given, and applying to the input image an edge detection using the existing methods (Sobel, Prewitt, Roberts, Laplacian and Canny [It uses a multistage algorithm to identify a large range of edges in an image]). Comparison of colour image edge detectors in numerous colour spaces, applying edge detection for the hue component then fused the images to get the output image.

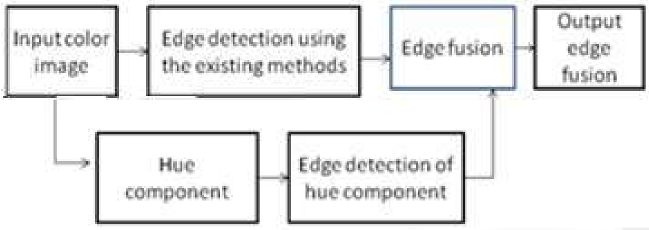

Figure H: Edge detection method to obtain complete object edges (adaptive from [1])

I. Fuzzy based edge detector

Fuzzy logic: Fuzzy means not clear, distinct, or precise, blurred. A form of knowledge demonstration suitable for design that cannot be defined correctly, but which depends upon their contexts called fuzzy logic.

Benefits of using Fuzzy logic-

(a) Fuzzy logic provides an another way to characterize linguistic and subjective attributes of the real world in computing.

(b) It is capable to be applied to control systems and other applications in order to recover the efficiency and simplicity of the design process.

The Fuzzy system contains four mechanisms such as fuzzifier, fuzzy interface, fuzzy knowledge base, and defuzzifier. The fuzzifier component is used to change the input into linguistic system. After the fuzzification, the fuzzy interface machine applies the fuzzy rules taken from fuzzy knowledge base, in chronological order. In the defuzzification process, the fuzzy data is transformed into a crisp data. The fuzzy system is shown in Figure 5.

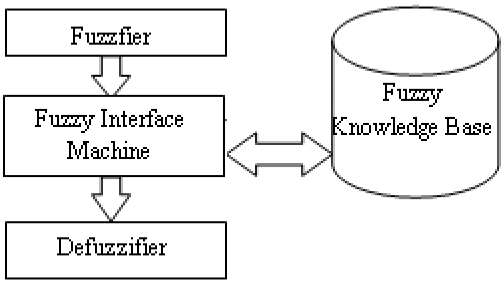

Figure I: Fuzzy system (adaptive from [12])

2. Edge Detection Techniques

A. An edge detection technique using canny operator

Firstly, this algorithm applies bilateral filtering to smooth the image, which not only has covered up the noise of the image, but also has well conserved the edges. Secondly, OTSU is performed to adaptively find out the low and high thresholds.

The Canny Edge Detection Algorithm has the following Steps:

Step 1: Smooth the image with a Gaussian filter.

Step 2: Calculate the gradient magnitude and direction using finite-difference approximations for the partial derivatives.

Step 3: Apply non maxima suppression to the gradient magnitude, use the double thresholding algorithm to identify and link edges. Canny edge detector approximates the operator that optimizes the creation of signal-to-noise ratio and localization. It is usually the first derivative of a Gaussian. For example:-

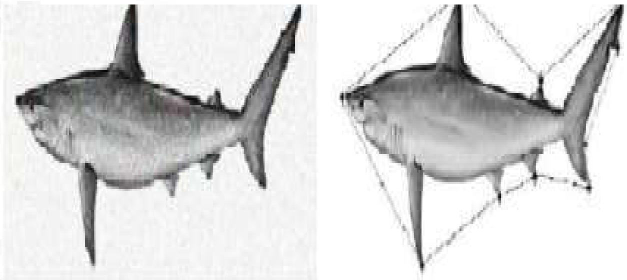

Figure A: Shark image (b) Edges using a Canny detector

The Smoothing is computed as $I[i,j]$to denote the image. $G[i,j,\sigma]$ has to be a Gaussian smoothing filters whereσ is the spread of the Gaussian and controls the degree of smoothing. The result of convolution of $I[i,j]$with $G[i,j,\sigma]$ gives an array of smoothed data as:

$$S[i,j] = G[i,j,\sigma] * I[i,j] \quad (1)$$

Firstly, the Gradient is calibrated for the smoothed array $S[i,j]$ is used to produce the x and y partial derivatives $P[i,j]$and $Q[i,j]$respectively as:

$$P[i,j] \approx (S[i,j+1]-S[i,j]+S[i+1,j+1]-S[i+1,j])/2 \quad (2)$$

$$Q[i,j] \approx (S[i,j]- S[i+1,j])+ S[i,j+1]- S[i+1,j+1]/2 \quad (3)$$

The x and y partial derivatives are computed with averaging the finite differences over the 2x2 square. From the standard formulas for rectangular-to-polar conversion, the magnitude and orientation of the gradient can be computed as:

Here the arctan(x, y) function takes two arguments and generates an angle. The Non maxima Suppression is evaluated using the magnitude image array. An edge point is defined as a point whose strength is locally maximum in the direction of the gradient. This is a stronger constraint to satisfy and is used to thin the ridges found by thresholding. This process which results in one pixel wide ridges which is called Non maxima suppression.

B. An edge detection using Laplacian operator

The Laplacian method searches for the zero crossings in the second derivative of the image to find edges.

International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Algorithm:

Step 1: Start with an image of a Shark as a sample Fig.7 (a) that is compared with the various types of other Sharks i0mages.

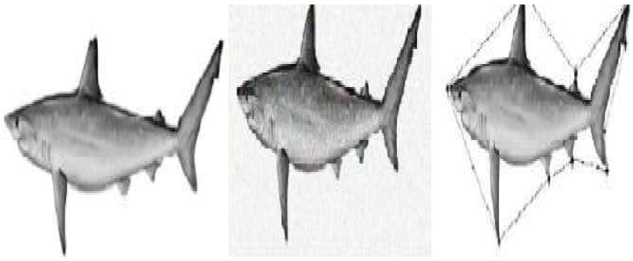

Figure B: (a) Shark Image (b) Image with noise (c) Image with edge detected

Step 2: Blur the image Fig. 7 b. On identifying the Shark type, the edges are selected to perform a morph, it is not really needed to detect the "every" edge in the image, but only in the main features Fig. 1.9.2c. Thus, the image has been blurred prior to edge detection. This blurring is accomplished by convolving image with a Gaussian.

Step 3: Perform the laplacian on this blurred image. It is necessary to perform the laplacian transformation. For example the laplacian operation is as follows:

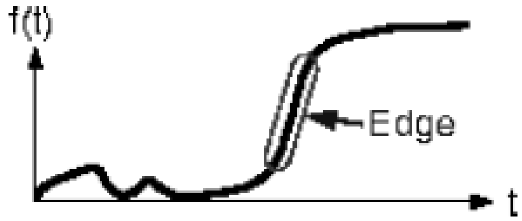

Figure B (a): First Derivative

Figure B (a) shows the gradient of this signal that has been marked which is in one dimension, which is the first derivative with respect to't'.

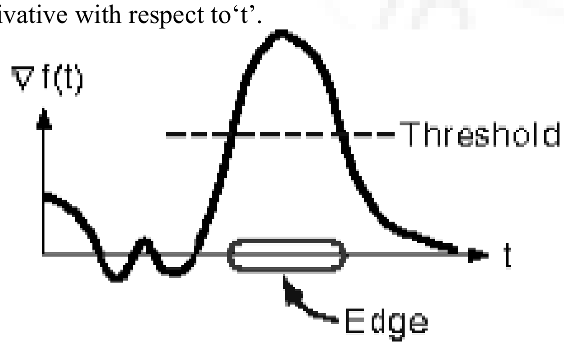

Figure B (b): Second Derivative

In Figure B (b) distinctly it shows the gradient which has a big peak centred on the edge. By comparing the gradient to a threshold, through the edge. Whenever the threshold is exceeded (as shown above). In this case, an edge is create, but the edge has become "concentrated" due to the thresholding. As the edge occurs at the peak, the laplacian operation can be applied in one dimension, it is the second derivative with respect to t and finding the zero crossings.

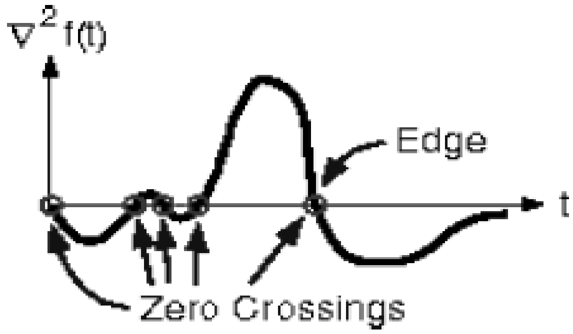

Figure B (c): Identification of Zero Crossing

C. An edge detection using Robert operator

The Roberts cross operator provide a simple approximation to the gradient magnitude:

$G[f[i,j]=f[i,j] + f[i+1,j+1] + f\{i+1,j\} - f[i,j1]$ **(4)**

Using convolution masks, this becomes:

$$G\left[f[i,j]\right] \dashv G \quad \textbf{(5)}$$

Where G_x and G_y are calculated using the following masks:

Table 1*:* Masks used by Roberts Operator

G_x =

1	0
0	-1

G_y =

0	-1
1	0

As with the preceding 2 x 2 gradient operator, the differences are computed at the interpolated point$[i+\frac{1}{2}, j+\frac{1}{2}]$. The Roberts operator is an approximation to the continuous gradient at the interpolated point and not at the point $[i,j]$ as it might be expected. As per the Roberts Edge Detection Filters, the image of the Shark is shown in the Fig 1.9.3.

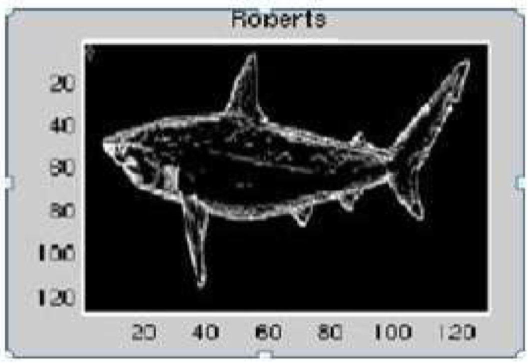

Figure C: Roberts Edge Detection Filter (sample)

D. An edge detection using Sobel operator: The Sobel operator is the magnitude of the gradient computed by:

$$M\sqrt{S_x^2 + S_y^2} \quad \textbf{(6)}$$

Where the partial derivatives are computed by:

$$s_x = (a_2 + ca_3 + a_4) - (a_0 + ca_1 + a_6) \quad \textbf{(7)}$$

$$s_y = (a_0 + ca_1 + a_2) - (a_6 + ca_5 + a_4) \quad \textbf{(8)}$$

With the constant c = 2. Like the other gradient operators, S_x and S_y can be implemented using convolution masks:

Table 2: Masks used by Sobel Operator

S_x=

-1	0	1
-2	0	2
1	0	1

S_y=

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

Note that this operator is placed on an emphasing pixels that are nearer to the centre of the mask. The Sobel operator is one of the most generally used edge detectors.

Table 3: The labelling of neighbourhood pixels

a_0	a_1	a_2
a_7	$[i,j]$	a_3
a_6	a_5	a_4

As per the Sobel Edge Detection Filters, the image of the Shark is shown in the Figure D (a).

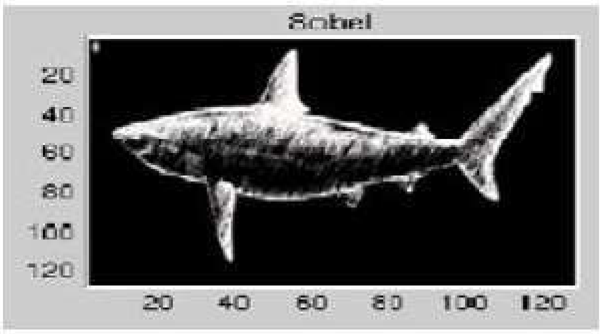

Figure D (a): Sobel edge detection filters

The next pair of images are shown in the horizontal and vertical edges preferred out of the collection shark images with the Sobel method of edge detection.

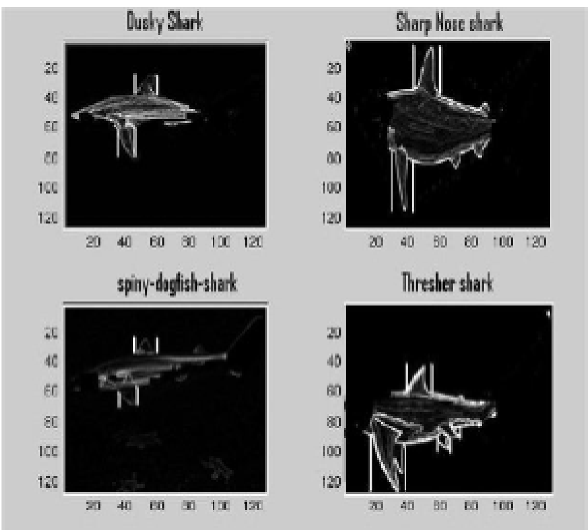

Figure D (b): Vertical Sobel Filter

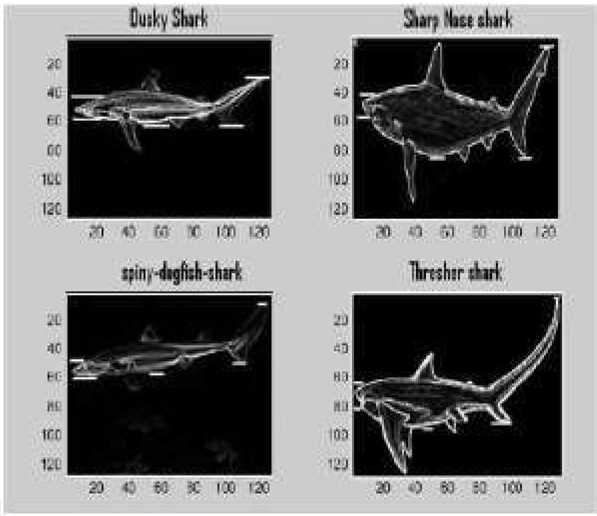

Figure D (c): Horizontal Sobel Filter

E. An edge detection using Prewitt operator: The Prewitt operator uses the same equations as the Sobel operator, where constant c = 1.

Table 4: Masks used by Prewitt gradient Operator

S_x =

-1	0	1
-1	0	1
-1	0	1

S_y =

1	1	1
0	0	0
-1	-1	-1

Therefore, not like the Sobel operator, this operator does not set any emphasis on pixels that are nearer to the center of the masks. As per the Prewitt Edge Detection Filters, the image of the Shark is shown in the Fig. 1.9.5.

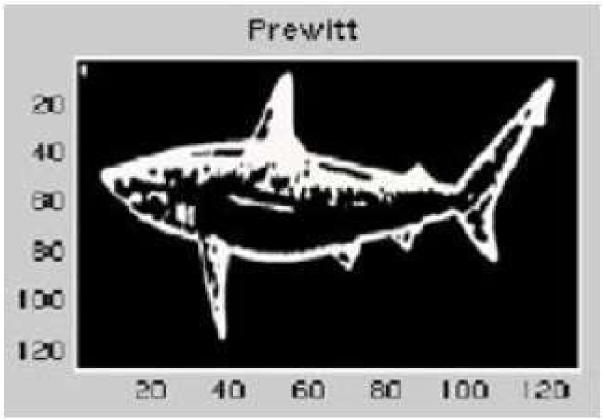

Figure E: Prewitt Edge Detection Filter

3. Related Work

Complete [1] object edges can be obtained by using the edge fusion of the first principal component and hue component of colour image with low-computational complexity. [2] has proposed hardware implementation of an edge detection method for colour images that exploits the definition of geometric product of vectors given in the Clifford algebra framework to extend the convolution operator and the

Fourier transform to vector fields. A new vector ordering [3] in RGB colour space has proposed. And then by analyzing the characteristics of the noise contaminating image, vector morphological operators has proposed and these operators are applied in colour edge detection.**[4]**has proposed a novel approach of edge detection for colour image in order to efficiently preserve edge in noise appearance. Firstly, multi-structure elements are designed in order to construct morphological gradient operators with performance of noise latter is consistent with human vision perception. Finally, we proposed morphological edge detection operators in HIS color space based on multi-structure elements.

"An improved Canny edge detection algorithm for colour image" byXin and Ki (2012) [5] has proposed an improved Canny algorithm to detect edges in color image. Algorithm is composed of the following steps: quaternion weighted average filter, vector Sobel gradient computation, non-maxima suppression based on interpolation, edge detection and connection. Algorithm is also applied to deal with colour images of transmission line icing.

A multi-scale edge detection algorithm [6] which took soft threshold method to implement detail enhancement and noise reduction of the true colour image. Firstly, obtaining the true colour images at different scales through wavelet multi-scale edge detection algorithm, then based on the improved soft threshold filter function, selecting appropriate threshold of the obtained image edges to perform noise reduction while enhance the edge details of the reservation; and finally, carrying out the weighted 2-norm fusion of edges of different-scale-image. The purpose of DSMT [7] is to overcome the limitations of DST mainly by proposing new underlying models for the frames of discernment in order to fit better with the nature of real problems, and proposing new efficient combination and conditioning rules. QFD [8] method is appropriate for constructing a local boundary model. A new concept: quaternion fractional differential (QFD), and apply it to edge detection of colour image. This method is called edge detection based on QFD.

An improved Kuwahara filter [9] is used to smooth the original image first. After edge detection with each channel independently in RGB colour space, an adaptive threshold selection method is applied to predict the optimum threshold value and an edge thinning algorithm is used to extract accurate edge. To generate a global ordering of spectral vectors [10], within a global ordering, a one-to-one correspondence between pixel values and scalars is guaranteed. The edge probability is only determined by the adjacent pixels. This method omits linearization and uses the SOM more efficiently for edge detection while also retaining greater flexibility.

The FPGA [11] resource usage is reduced more than 35% as compared to standard implementation which uses three gradient computation blocks. Proposed architecture is integrated with camera interface module logic which captures the data in real-time and DVI controller logic which displays results on monitor. A [12] novel edge detection method based on 32 fuzzy rules. Edge detection is one of the pre-segmentation processes of MRI head scans. It detects edges in a better way than the traditional Canny edge detector and Sobel edge detection operator and thus takes less time for edge detections. It produces sharp and clear edges that can be used for segmenting brain portions in MRI of human head scans. An adaptive threshold edge detection [13] which applies the bilateral filtering it uses OTSU, which is based on gradient magnitude to maximize the separability of the resultant classes, to determine the low and high thresholds of the canny operator. Finally, the edge detection and connection has performed.

4. Gaps in Earlier Work

Most of the existing research uses presented edge detectors [attached paper] prewitt, canny, Sobel etc. Although these are based on the optimization theory, in real time, it does not commonlypresent optimally.

1. Firstly, these operators smoothes the input image with Gaussian filter, that has also smoothed the high frequent motions which may be the edges presented in the input image. Therefore will lose some potential edges in the input image.
2. Also the high and low thresholds are set by hand [13] necessitating preceding experimental knowledge and it is likely to get an suitable threshold after many experimentations.
3. However, in real time, the high and low thresholds normally change because of the scenes and brightness variation is there.
4. The conventional operator's; need of the proficiency of self-adaptation, in numerous cases, it has not capability to get a considerable recognition consequences.

5. Conclusion& Future work

This paper has shown various techniques for edge detection. Survey has shown that still much research is required in the field of colour based edge detection. This paper has focused on detecting the edges for the hue factor in Human visual system (HSV). Hue is usually represented by position significance, so the existing edge detection techniques are incapable to correctly perceive edges of hue factor in HSV colour plane. As a consequence, the most popular approaches of colour edge detection typically neglect the role of hue factor, thus misplaced some edges triggered by hue variations. In near future a new colour edge detection technique model will be proposed to improve the performance of edge detection for complex background images.

References

[1] Lei, Tao, Yangyu Fan, and Yi Wang. "Colour edge detection based on the fusion of hue component and principal component analysis." *IET Image Processing* 8.1 (2014): 44-55.

[2] Franchini, Silvia, et al. "Clifford Algebra Based Edge Detector for Colour Images."*Complex, Intelligent and Software Intensive Systems (CISIS), 2012 Sixth International Conference on*. IEEE, 2012.

[3] Wang, Lei, and Lingbo Yan. "Edge detection of colour image using vector morphological operators." *Computer*

Science and Network Technology (ICCSNT), 2012 2nd International Conference on. IEEE, 2012.
[4] Xu, Hui, Yani Zhang, and Haiyan Zhao. "Edge detection of colour image using mathematical morphology in HSV colour space." *Computer Science and Network Technology (ICCSNT), 2012 2nd International Conference on*. IEEE, 2012.
[5] Xin, Geng, Chen Ke, and Hu Xiaoguang. "An improved Canny edge detection algorithm for colour image." *Industrial Informatics (INDIN), 2012 10th IEEE International Conference on*. IEEE, 2012.
[6] Xiao, Feng, Mingquan Zhou, and GuohuaGeng. "Detail enhancement and noise reduction with true colour image edge detection based on wavelet multi-scale."*Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC), 2011 2nd International Conference on*. IEEE, 2011.
[7] Dezert, Jean, Zhun-ga Liu, and Grégoire Mercier. "Edge detection in colour images based on DSmT." *Information Fusion (FUSION), 2011 Proceedings of the 14th International Conference on*. IEEE, 2011.
[8] Gao, C. B. "Edge detection of colour image based on quaternion fractional differential." *Image Processing, IET* 5.3 (2011): 261-272.
[9] Chen, Xin, and Houjin Chen. "A novel colour edge detection algorithm in RGB colour space." *Signal Processing (ICSP), 2010 IEEE 10th International Conference on*. IEEE, 2010.
[10] Jordan, Johannes, and Elli Angelopoulou. "Edge detection in multispectral images using the n-dimensional self-organizing map." *Image Processing (ICIP), 2011 18th IEEE International Conference on*. IEEE, 2011.
[11] Singh, Sanjay, Chandra Shekhar, and Anil Vohra. "Area optimized FPGA implementation of colour edge detection." *Advanced Electronic Systems (ICAES), 2013 International Conference on*. IEEE, 2013.
[12] Somasundaram, K., and K. Ezhilarasan "Edge detection in MRI of head scans using fuzzy logic." *Advanced Communication Control and Computing Technologies (ICACCCT), 2012 IEEE International Conference on*. IEEE, 2012.
[13] Jie, Gao, and Liu Ning**.** "An improved adaptive threshold canny edge detection algorithm." *Computer Science and Electronics Engineering (ICCSEE), 2012 International Conference on*. Vol. 1. IEEE, 2012.
[14] R. Gonzalez and R. Woods. "*Digital Image Processing"*, Addison-Wesley Publishing Company, 1992, pp 518 - 548.

Author Profile

Sheffali Bamba studied M.Tech from Global Institute of Management & Emerging Technologies (Punjab Technical University).