An Efficient Edge Detection Approach based on Bacterial Foraging Optimization

Kiranjeet Kaur[1], Sheenam Malhotra[2]
[1]Research Fellow, [2]Asst. Professor
[1,2]Sri Guru Granth Sahib World University,Fatehgarh Sahib,Punjab.

Abstract — Edge Detection is an important task in the image processing. Edge detection of noisy images is simpler but after adding noise image gets degraded so, edge detection is more difficult. This paper proposed an enhanced edge detection algorithm BFO using combination of three filters. In this firstly add salt & pepper noise then filter this image by using Gaussian filter. After filtering with Gaussian filter, two more filters used that are bilateral and trilateral to make image noise free. Then we use BFO for edge detection. We can compare our results by calculating PSNR & MSE values and proof that our results are better than the previous methods.

***Keywords*— Edge Detection, BFO, Gaussian Filter, Bilateral Filter, Trilateral Filter, PSNR,MSE.**

I. INTRODUCTION

Edge detection may be a vital space within the field of image processing .The function of edge detection is to identify the boundaries of homogenous regions in a picture based on properties such as intensity and texture.Some early conventional methods for edge detection are Sobel algorithm,Prewitt algorithm and Laplacian of Gaussian operator. But they belong to high pass filtering methods,which are not effective for noisy images because noise and edge belong to the scope of high frequency.In real world applications,image contain object boundaries ,object shadows and noise.it may be difficult to distinguish the exact edge from noise or trivial geometric features.s[1].

Edge of an image are considered a type of crucial information that can be extracted by applying detectors with different methodology. The main purpose of edge detection is to simplify the data in order to minimize the amount of data to be processed.To methods for first order derivatives edge detection-one of the methods is evaluating the gradiented generated along two orthogonal directions.The second approach of the first order derivative edge detection is utilizing a set of discrete edge templates with different orientations.The edge detected by comparing the edge gradient to a defined threshold value.[2] The Gaussian filter has been used extensively in image processing and computer vision for many years.In gray level image an edge may be defiend as a sharp change in intensity.Edge detection is the process which detects the presence and locations of these intensity transitions.The sobel and Prewitt detectors used local gradient operator which only detector edges having certain orientations and performed poorly when tha edge were blurred and noisy. Edge localization is another problem encountered in edge detection.The addition of noise to an image can cause the position of detected edge to be shifted from its true location.[3].Most of the classical methods for edge detection based on the derivative of the pixels of the original image are Gradient operators,Laplacian and Laplacian of Gaussain(LOG) operators.Gradient based edge detection methods such as Roberts,Sobel and Prewitt have used two 2-D linear filters to process vertical edges and horizontal edges separately to approximate first order derivative of pixel value of the image The hybrid entropic edge detector uses both Shannon entropy and Tsallis entropy together. The hybrid entropic edge detector decreases the computation time with generate high quality of edge detection [4] Filtering is perhaps the most fundamental operation of image processing and computer vision. In the broadest sense of the term "filtering," the value of the filtered image at a given location is a function of the values of the input image in a small neighborhood of the same location. In particular, Gaussian low-pass filtering computes a weighted average of pixel values in the neighborhood, in which, the weights decrease with distance from the neighborhood center[5]

The bilateral filter is very effective one pass adaptive filter for denoising purposes while keeping the edges relatively sharp. Since its advent, the idea of bilateral filtering has been modified and improved, and its relation to some of the most popular image enhancement and reconstruction algorithms has been established.It is proved that such filter is a single Jacobi iteration of a weighted least squares minimization, and suggested using more iterations to enhance the smoothing effect of estimation.[6].Edges and textures in an image are typical examples of high-frequency information. High-pass filters remove low-frequency image information and therefore enhance high-frequency information such as edges. Many approaches to image interpretation are based on edges, since analysis based on edge detection is insensitive to change in the overall illumination level. Edge detection highlights image *contrast*. Detecting contrast, which is difference in intensity, can emphasize the boundaries of features within an image, since this is where image contrast occurs. This human vision can perceive the perimeter of an object, the object is of different intensity to its surrounding.Edge detection is important preprocessing step for any image processing application[7].

II. EDGE DETECTION

Edge detection refers to the method of characteristic and locating sharp discontinuities in a picture. The discontinuities area unit abrupt changes in constituent intensity that characterize boundaries of objects in a very scene. Classical ways of edge detection involve convolving the image with associate degree operator (a 2-D filter), that is made to be sensitive to massive gradients within the image whereas returning values of zero in uniform regions. This can be a particularly sizable amount of edge detection operators offered, every designed to be sensitive to bound kinds of edges. Variables concerned within the choice of a footing detection operator include:

- Edge orientation: The pure mathematics of the operator determines a characteristic direction during which it's most sensitive to edges. Operators are optimized to seem for horizontal, vertical, or diagonal edges.

- Noise environment: Edge detection is troublesome in screeching pictures, since each the noise and therefore the edges contain high-frequency content. tries to cut back the noise lead to blurred and distorted edges. Operators used on screeching pictures area unit usually larger in scope, in order that they will average enough information to discount localized screeching pixels. This leads to less correct localization of the detected edges.

- Edge structure: Not all edges involve a step amendment in intensity. Effects like refraction or poor focus may end up in objects with boundaries outlined by a gradual amendment in intensity. The operator has to be chosen to be alert to such a gradual amendment in those cases. Newer wavelet-based techniques really characterize the character of the transition for every draw near order to tell apart, for instance, edges related to hair from edges related to a face.

There is a unit many ways to perform edge detection. However, the bulk of various ways is also classified into 2 categories:

(i) Gradient: The gradient methodology detects the sides by craving for the utmost and minimum within the derivative of the image.

(ii) Laplacian: The Laplacian methodology searches for zero crossings within the second by-product of the image to search out edges. a footing has the one-dimensional form of a ramp and hard the by-product of the image will highlight its location.

Clearly, the by-product shows a most placed at the centre of the sting within the original signal. This methodology of locating a footing is characteristic of the "gradient filter" family of edge detection filters and includes the Sobel methodology. A constituent location is said a footing location if the worth of the gradient exceeds some threshold. As mentioned before, edges can have higher constituent intensity values than those encompassing it. Therefore once a threshold is about, you'll compare the gradient price to the edge price and sight a footing whenever the edge is exceeded. What is more, once the primary by-product is at a most, the second by-product is zero. As a result, another various to finding the placement of a footing is to find the zeros within the second by-product. This methodology is understood because the Laplacian and therefore the second by-product of the signal.

The purpose of selecting sharp changes in image brightness is to capture vital events and changes in properties of the planet. It is shown that below rather general assumptions for a picture formation model, discontinuities in image brightness area unit seemingly to correspond to:

- Discontinuities thorough,
- Discontinuities in surface orientation,
- Changes in material properties and
- Variations in scene illumination.

In the ideal case, the results of applying a footing detector to a picture could cause a collection of connected curves that indicate the boundaries of objects, the boundaries of surface markings additionally curves that correspond to discontinuities in surface orientation. Thus, applying a footing detector to a picture could considerably scale back the quantity of knowledge to be processed and should so separate information that will be considered less relevant, whereas protective the vital structural properties of a picture. If the sting detection step is winning, the next task of decoding the knowledge contents within the original image could so be considerably simplified. sadly, however, it's not invariably potential to get such ideal edges from reality pictures of moderate quality. Edges extracted from non-trivial pictures area unit typically hampered by fragmentation, which means that the sting curves aren't connected, missing edge segments additionally as false edges not equivalent to attention-grabbing phenomena within the image -- therefore complicating the next task of decoding the image information.

III. PROPOSED APPROACH USING BFO & THREE FILTERS

Edge detection of pictures is a vital task in computer vision and image processing. Edge detection of noise free pictures is comparatively less complicated, however in

most sensible cases the photographs area unit degraded by noise. To seek out the perameters from pictures may be a difficult task. There are large numbers of edge detection operators available, every designed to be sensitive to sure varieties of edges. The standard of edge detection will be measured from many criteria objectively. Some criteria area unit planned in terms of mathematical activity, a number of them area unit supported application and implementation needs.

3.1 Proposed Model

In our proposed work, the mathematical filter (Bilateral and Trilateral) quite effectively. Within the initial section we have a tendency to transfer the image with the graphical program provided by Matlab software package. The results are tested on normal pictures like Leena. The objectives of our proposed work are:

- To propose an efficient edge detection algorithm.
- Remove noise using three filters that are Gaussian Filter, Bilateral Filter, and Trilateral Filter.
- Use BFO method with filters to implement edge detection.
- Comparison with previous techniques like Sobel Edge Detector and Roberts Edge Detector.

3.2 Basic Block Design

Edges in photos provide low-level cues, which could be utilized in higher level processes, like object detection, recognition, and classification, furthermore as motion detection, image matching, and trailing. Edges and textures in image are typical samples of high-frequency information. High-pass filters deduct low-frequency image information and therefore enhance high-frequency information like edges. Many approaches to image interpretation measure supported edges. since analysis supported edge detection is insensitive to vary among the illumination level.

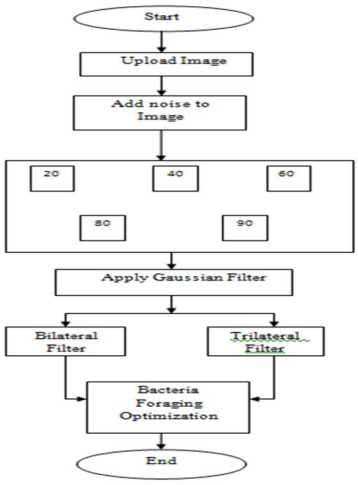

Fig 1 Basic Block Design of Proposed Work

Fig 1 shows the basic block design of the proposed model. The uploaded image is provided with the noise called salt & pepper and Gaussian noise. We have also tested the code with the increased and decreased level of noise. Like we have increased the noise level by twenty, forty and sixty, eighty and ninety percent of the noise level. By default the taken noise level is ten percent.

The added noisy image is provided to the Gaussian filter. The Gaussian filter sharpens its edges to a very good extent so that we can spot out the noise level and can decide an overall threshold value of the noisy image. Once the threshold value is decided, it applies the same threshold value to each and every pixel taken for the consideration. The output of the Gaussian filter is then provided to the Bilateral Filter. Then filtered image goes to BFO method for edge detection.

The same procedure goes with the trilateral filter as well. The difference which leaves its mark in using the trilateral filter is that it does not allow the segment to set the threshold value similar for all pixels. It divides the image into blocks and sets the threshold filtration value according to the different blocks. When a much sharpened image goes to the BFO it certainly provides better output in terms of image quality which is termed as the PSNR of the image as well as MSE parameter.

3.3 Algorithm level Design

Fig. 2 represents the flow of steps involved in algorithm level design of the Enhanced Approach.

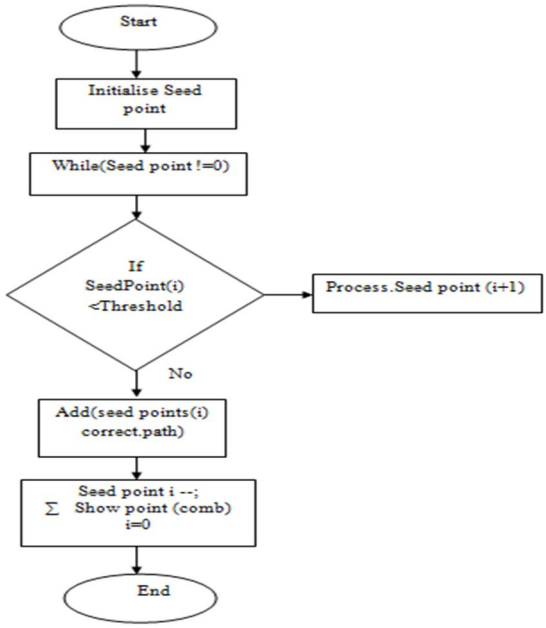

Fig 2 Proposed Algorithm level Design of BFO

Bacterial Foraging Optimization (BFO) Algorithm:

Bacterial forage improvement algorithmic rule (BFO) has been wide accepted as a world improvement algorithmic rule of current interest for distributed improvement and management. BFO has already drawn the eye of researchers due to its efficiency in finding real-world improvement issues arising in many application domains.

BFO is impressed by the social forage behavior of bacteria i.e. how Bacteria search for nutrients in manner to maximize energy obtained per unit time. An individual bacterium communicates with others by sending signal. The process, in which a bacterium moves by taking small steps while searching for nutrients, is called chemotaxis

IV. RESULTS

The digital square color image samples of resolution 225 x 225 is given as input and output as edges of image is produced. Digital images as input is given and edges of that image are produced. Results are shown as below:

Fig 3 Testing Images

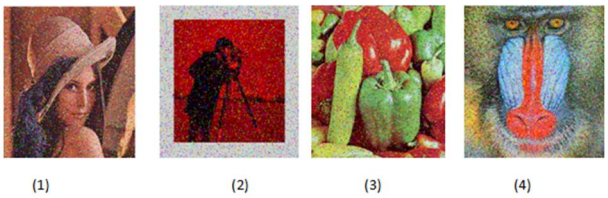

Fig 4 Images with salt and pepper noise

Fig 5 Filtered Image using Gaussian Filter

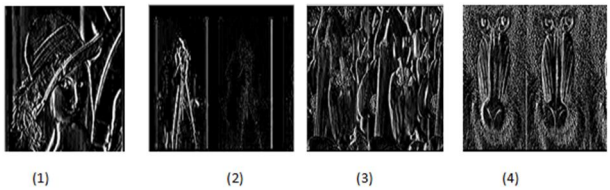

Fig 6 Filtered Image using Bilateral Filter

Fig 7 Edge Detection using BFO

We can compare our results in terms of PSNR & MSE as shown in table 1 and table 2. Table shows the PSNR & MSE values calculated by our proposed technique, and previous techniques by using samples of four images as shown above. In this work, we used number of images as samples but here we compare the values calculated only by four images. A previous technique includes Sobel Edge detector and Robert Edge detector. Fig 8 & Fig 9 shows the comparison of all three techniques and shows that our results are better than the previous one.

Table 1 Comparison of combination of three filters and BFO with Other Techniques Based on PSNR

Sample Image Number	PSNR		
	Sobel Edge Detector	Robert Edge Detector	Enhanced Approach using BFO
(1)	50.9	51.0	58.5
(2)	49.0	49.9	59.8
(3)	41.5	41.7	59.1
(4)	41.74	36.9	58.4

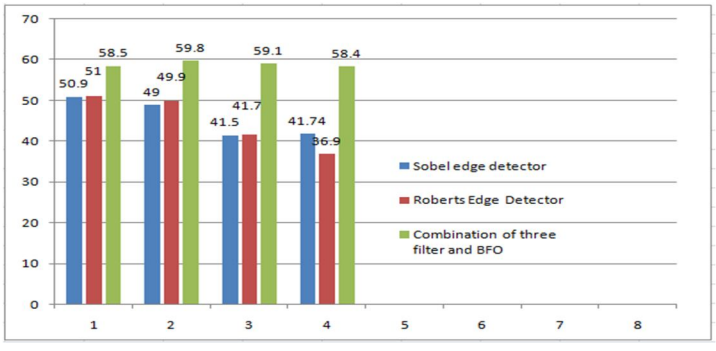

Fig 8 Comparison with other techniques Based on PSNR values.

Table 2 Comparison of combination of three filters and BFO with Other Techniques Based on MSE

Sample Image Number	MSE		
	Sobel Edge Detector	Robert Edge Detector	Enhanced Approach using BFO
(1)	0.52	0.51	0.41
(2)	0.73	0.72	0.62
(3)	0.64	0.69	0.59
(4)	0.53	0.8	0.7

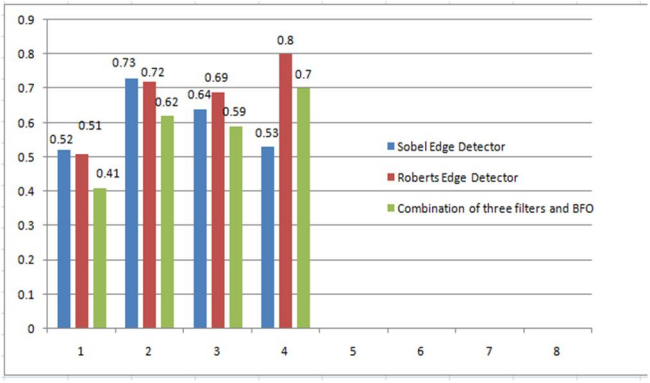

Fig 9: Comparison with other techniques Based on MSE values.

V. CONCLUSION

The detection of the edge is one of the important part in the field of Image Processing. In this paper we proposed an efficient BFO based algorithm for images edge detection. The detection is basically done as per the natural phenomenon of BFO. In this we use different combination for filtering like filtering with Gaussian & Bilateral filter and Gaussian & Trilateral filter. Then we use BFO that is bacterial foraging optimization algorithm. This technique achieves better results as compare to the Sobel edge detection & Robert edge detection technique.

REFERENCES

[1] M Rama Bai , Dr V Venkata Krishna and J SreeDevi , "*A new Morphological Approach for Noise Removal cum Edge Detection*," IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 6, November 2010.

[2] Tzu-Heng Henry Lee and Taipei, Taiwan ROC, "*Edge Detection Analysis*," IJCSI International Journal of Computer Science Issues, Vol. 5, Issue 6, No 1, September 2012.

[3] Mitra Basu, Senior Member IEEE, "*Gaussian-Based Edge-Detection Methods—A Survey*," IEEE Transactions on System,man,and cybernetics-part c:Application and Reviews,Vol. 32, No. 3, August 2002.

[4] Mohamed A. El-Sayed, "*A New Algorithm Based Entropic Threshold for Edge Detection in Images*," IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011.

[5] C. Tomasi and R. Manduchi, " *Bilateral Filtering for Gray and Color Images*," Proceedings of the 1998 IEEE International Conference on Computer Vision, Bombay,India.

[6] Hiroyuki Takeda, Sina Farsiu and Peyman Milanfar, "*Higher Order Bilateral Filters and Their Properties*," Electrical Engineering Department, University of California,
1156 High St., Santa Cruz, CA, USA

[7] Akansha Mehrotra,Krishna Kant Singh,M.J.Nigam, "*A Novel Algorithm for Impulse Noise Removal and Edge Detection*," International Journal of Computer Applications (0975 – 8887) Volume 38– No.7, January 2012.

[8] Swagatam Das, Arijit Biswas, Sambarta Dasgupta, and Ajith Abraham, "*Bacterial Foraging Optimization Algorithm*: Theoretical Foundations, Analysis, and Applications"

[9] M.Y.Jiang,and D.F.Yuan "*A multi-grade mean morphologic edge detection*" 6th International Conference on Signal Processing Beijing, China, pp.1079-1082, 2002.

[10] Hossein Nezamabadi-pour · Saeid Saryazdi Esmat Rashedi, *Edge detection using ant algorithm*", in proc. of Springer-Verlag, pp.623- 628, 2005.

[11] Raymond H. Chan, Chung-Wa Ho, and Mila Nikolova,"*Salt-and-pepper noise removal by median-type noise detectors and detail-preserving regularization*",*IEEE Transactions on Image Processing*, vol. 14, no. 10, pp. 1479–1485, Oct. 2005.

[12] X. Zhuang, "*Edge Feature Extraction in Digital Images with the Ant Colony System*" in proc. of the IEEE international Conference an computational intelligence for Measurement Systems and Applications, pp. 133-136,2004.

[13] Hossein Nezamabadi-pour,Saeid Saryazdi Esmat Rashedi, "*Edge detection using ant algorithms*", in proc. of Springer-Verlag, pp.623-628, 2005.

[14] Feng-ying Cui ,Li-jun Zou and Bei Song , "*Edge Feature Extraction Based on digital Image processing techniques,*" Proc. IEEE International conference Automation and logistics, Qingdao,China September 2008.