A REALTIME NOISE REMOVAL IN CAPTURING WILDLIFE PHOTOGRAPHY USING BILATERAL FILTER COMPARED OVER GAUSSIAN FILTER WITH IMPROVED ACCURACY

Katari Rahul[1], V. Karthick[2*]

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Abstract

Aim: The research aims at performing noise removal in capturing wildlife photography by applying Bilateral Filter with improved accuracy compared to Gaussian Filter technique.
Materials and Methods: The study contains application of Bilateral and Gaussian filters for attaining noise removal over images and are the two groups which contain 104 samples in total. These 104 samples are divided as 52 each and the sampling technique.
Results: The performance has been improved in terms of accuracy for the Bilateral Filter algorithm with 86.9% while the Gaussian filter algorithm has shown an accuracy of 85.2%. The mean value is 86.9, mean accuracy detection is ±2SD Bilateral Filters and the significant value is .006 ($p<0.05$) from an independent sample T test from Sig 2-tailed.
Conclusion: The final outcome of the Bilateral Filter (86.9%) algorithm is found to be significantly more accurate than the Gaussian Filter algorithm (85.2%).

Keywords: Novel Denoise Filter**,** Bilateral Filters, Gaussian Filter, Noise Removal, Gaussian Noise, Image Processing.

[1]Research Scholar, Department Of Computer Science And Engineering, Saveetha School Of Engineering, Saveetha Institute Of Medical And Technical Sciences, Saveetha University,Chennai, Tamilnadu, India. Pincode: 602105.
[2*]Project Guide Department of Computer Science and Engineering,Saveetha School of Engineering,Saveetha Institute of Medical And Technical Sciences,Saveetha University, Chennai, Tamilnadu, India. Pincode: 601205.

Email: [1]Rahulk18@Saveetha.Com , [2*]karthickv.sse@saveetha.com

1. Introduction

Image Processing application involves processing of images in respective fields of Photography, Computer Graphics, (Zhong and Li 2017) camera mechanism, signal processing, Satellite communications, UV imaging, X-Ray analysis. While transmission of images (Zhong and Li 2017; Baruah et al. 2022), processing of captured photographs, image recognition, medical image retrieval and so on other processes develop the possibility of affecting image sources (Villetard 2020). A Bilateral filter model with Novel Denoise Filter is designed which maintains Image sharpness, real texture, smoothness, reducing blur, edge preservation effects over Gaussian Filter Model which reduces image detail, edge distortion in denoising a image source in Bilateral Filters (Deepak., John Justin Thangaraj, and Rajesh Khanna 2020).

There are about 750 articles from various sources such as Google Scholar, IEEE Xplore and Springer. Noise removal in Image processing was achieved by using Filter based algorithms like Inverse, Bilateral, Gaussian, Mean, Median, Wiener filters which is found to be close to this research article. Typical types of images were Binary images, (Santos, Pyrcz, and Prodanović 2022) gray scale images, color images exist in Digital media (Araz et al. 2022). Denoising these kinds of Novel Denoise Filter and Bilateral Filters images were carried out by (Lv et al. 2022) Filter based algorithms.Our team has extensive knowledge and research experience that has translated into high quality publications(K. Mohan et al. 2022; Vivek et al. 2022; Sathish et al. 2022; Kotteeswaran et al. 2022; Yaashikaa, Keerthana Devi, and Senthil Kumar 2022; Yaashikaa, Senthil Kumar, and Karishma 2022; Saravanan et al. 2022; Jayabal et al. 2022; Krishnan et al. 2022; Jayakodi et al. 2022; H. Mohan et al. 2022)

Aim of this paper is to remove noise in applying Bilateral Filter with improved accuracy compared to Gaussian Filter technique. Types of noise classified (Park 2017) as photoelectronic, impulse and structured noise. Photo (Park 2017; Evans, Malhotra, and Bowers 2021) electronic noise includes photon and thermal noise (Padullaparthi, Tatum, and Iga 2021) effects. Impulse noise deals with dark (Padullaparthi, Tatum, and Iga 2021; Vyas, Yu, and Paik 2017) bright noise popularly known as salt and pepper noise. Poisson noise is photon noise observed in X-ray processing, imaging systems in medical analysis. Gaussian Noise and Novel Denoise Filter is a statistical noise basically developed by thermal and radiation effects (Rahman and Saleh 2018). Image source quality was affected by noises such as gaussian noise, speckle noise, salt and pepper noise, poisson noise which is the research gap of this work.

2. Materials and Methods

This research paper had been carried out in the Department of Artificial Intelligence Laboratory of Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences. Here cars dataset which comprises 4200 images downloaded from www.kaggle.com was utilized by both the algorithms (Nugroho et al. 2020) . The paper contains 2 groups where the 1st group is Bilateral Filter algorithm with 89% following that 2nd group was Gaussian filter algorithm which has accuracy of 87%. There are about 112 samples in which 56 were from the first group and the remaining 56 from the second group with g power as 83% along with confidence interval as 95% and enrollment ratio is set to be 1using Novel Denoise Filter and Bilateral Filters.

The dataset is provided clean by removing irrelevant images. For installing the specified software a minimum of 320 GB hard disk space is required and in the same it is utilized for downloading required files for complete installation. And 8GB RAM is required to run the software smoothly without any interruption along with the i5 processor to make sure that each and every processes are running parallely in Image Processing. A minimum of 3GB graphics card would generate the results faster for recognizing the objects. Kaggle online development environment had been used to run the framework specified.

Bilateral Filter Algorithm

Gaussian a low pass filter model calculates weighted mean of nearby pixels present in image.The noise present in images affects neighbor pixels by distributing similar values thereby corrupting the image signal passed for further processing. It makes image blur and modify details maintained within the image. In addition, edges of images were altered resulting in poor quality of images in Novel Denoise Filter.

There is a necessity to model a Bilateral Filter which adapts non-linear denoise technique for preserving fine edges and acts as a smoothing filter too. Bilateral is a shift-invariant Gaussian Filtering model. Bilateral Filter modifies intensity of pixel based on computation of weighted mean of neighbor pixels. The weight calculation is based on gaussian distribution , difference between pixel range like depth, intensity of color thereby maintaining sharpness with Gaussian noise and smooth quality of images. Bilateral Filter and Novel Denoise Filter have a huge contribution in developing Computer Graphics Processing Systems.

Step 1: Read the Image source S with x,y coordinates. S(x,y)

Step 2: Declare a variable Sf to receive a denoised image after the filtration process.

Step 3: Obtain Window value for center pixel V(i,j).
Step 4 : Compute range between Pixels Rp and spatial value Sp difference between pixels
Step 4: Assign weight Wt using parameters Rp and Sp computed from Step3
Step 5: Assume a Pixel is stored in S(a,b) to be filtered from noise,S(c,d) holds nearby pixel
Step 6: Pass the values of S(c,d) to parameter Wt in STEP 4 to remove noise present in S(a,b).
Step 7: Pass the values of (a,b,c,d) to calculate weight for pixel intensity along with smoothing
Step 8: Variables Sd and Sr which hold sigma values from gaussian function .
Step 9: From the computed weights of Step7 apply normalization to obtain denoised image
Step 10: Pass the denoised image to Sf for displaying filtered Image.

Gaussian Filter Algorithm
A Gaussian Filter is a low-pass filter with high frequency components used to Blur images and reduce detail for graphic transformation. It compares the pixel values of pixels and approximates with gaussian function to perform noise removal in images. It has wide application in Computer Graphics systems. Utilizes mean values of pixels and performs distribution function using standard deviation .
Step 1: Provide Image I with coordinates of height 'h' and width 'w' I(h,w) to be processed.
Step 2: Read the coordinate values of h , w from input image source passed.
Step 3: Define a constant PI . Assign PI value as 3.14.
Step 4: Define a variable Sd for obtaining value from standard deviation
Step 5: Pass the parameters PI , h, w to Gaussian distribution function.
Step 6: Get computed values of mean comparison M(h,w) and standard deviation
value Sd from Step 5
Step 7: Continue the process until maximum Sd values are received.
Step 8: Further pass the output image to Variable Id which holds a denoised image.
Step 9: Stop process while better mean value is attained else Goto Step2.

Statistical Analysis
The analysis had been carried out using IBM SPSS version 21, a statistical software tool for data analysis. Group statistics comparison for mean, standard deviation and standard error were calculated for the Bilateral Filter algorithm over the existing Gaussian Filter algorithm. Independent variables are accuracy, Standard deviation and standard mean error and dependent variable is the visual behaviour set. The analysis of research work done using Independent T-Test had been performed to find mean, standard deviation which is used to compare Bilateral Filter algorithms and Gaussian filter algorithm, thereby preventing image from damage and quality was assured.

3. Results

The comparative analysis of the existing and the proposed algorithms is carried out by taking the accuracy rate of detection for both the algorithms using Bilateral Filters. The drowsiness prediction accuracy for both the algorithms is taken and can be used for analysis and comparison. The proposed algorithm is said to be more accurate than the existing algorithm, and the accuracy rate of the proposed algorithm is found to be 86.9%.
Table 1 shows the comparison of the accuracies of Novel Bilateral Filter and Gaussian Filter algorithm for a sample size of N=10.
Table 2 depicts the group statistics which shows the mean accuracy percentage is 86.9% and the standard deviation is 0.80417 for the sample size N=52 whereas the mean accuracy percentage is 85.2% with standard deviation as 1.07540 for sample size N=52.
Table 3 is an independent sample T-test with confidence level 95% which compares the Novel Bilateral Filter and Gaussian Filter algorithm.
Table 4 shows the bivariate correlation of the accuracies of the both Novel Bilateral Filter and Gaussian Filter algorithm where it has a correlation as 0.45.

4. Discussion

Based on the result, Bilateral Filter (89%) appears to be better than the Gaussian Filter Algorithm (87%). The values of the Mean filter are analyzed statistically and the difference is found out by plotting the graph against the algorithms.
Similar findings are efficient (Longère et al. 2021) in providing Sharper images and Best smoothing of image quality compared to other filter models (Amirrashedi et al. 2021). In addition it applies a gaussian function for developing denoise effects. It maintains a fine scale of color images, Gray scale (Vahabi et al. 2021) images as well as the best fault identification Model. Removes blur effect of images caused by gaussian noise too (Vahabi et al. 2021; Celebi, Lecca, and Smolka 2015). Whereas a Gaussian filter fails to maintain image sharpness and affects edges during the filtration process.

Only disadvantage of the bilateral filter model (Nugroho et al. 2020) is that computational cost is too high for preserving edges, sharpness quality compared to other model filters in the denoising image process. In future, due to sharpness quality and edge preservation, Bilateral filter is more applicable in Medical diagnosing, Imaging

Softwares, (Chen et al. 2021) Graphical Interface developments, Space Photograph developments, Radar signal processing and on the go.

5. Conclusion

The research study found that the proposed Bilateral Filter algorithm is significantly efficient and accurate compared to the Gaussian Filter algorithm. The accuracy of the prediction of the proposed algorithm is found to be 89%, and hence using the proposed algorithm gives better results compared to the existing algorithm that has accuracy of 87%.

Declarations

Conflict of Interest

No conflict of interest in this manuscript

Author Contribution

Author GVH is involved in data collection, data analysis and manuscript writing**.** Author VK was involved in conceptualization, data validation and critical review of the manuscript.

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TABLES AND FIGURES

Table 1. Comparative study between the Gaussian Filter algorithm and the Bilateral Filter algorithm with accuracy rate

S.No	BILATERAL FILTER	GAUSSIAN FILTER
1.	86	85
2.	86	85
3.	89	87
4.	86	84
5.	86	84
6.	88	84
7.	86	84
8.	88	87
9.	87	87
10.	87	85

Table 2. Group statistics T-Test for existing algorithm Gaussian (85.2) and Bilateral Filter Algorithm (86.9) with the sample size 10. There is a statistically slight difference in the SD accuracy of the two algorithms. The Bilateral Filter algorithm had the highest accuracy(1.10050) and the Gaussian Filter (1.31656).

Pair 1	N	Mean	Std.Deviation	Std.Mean Error
Gaussian Filter	10	85.2	1.31656	0.41633
Bilateral Filter	10	86.9	1.10050	0.34801

Table 3. Independent sample T-test with confidence level 95% and which shows the difference between two groups. The accuracy for equal variance assumed and equal variance will be compared.

	Levene's test for equality of variances.		T- test for equality of means						
ACCURACY	F	Sig.	t	df	Sig.(2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
								Lower	Upper

Equal variance assumed	.433	0.456	3.133	18	.006	1.70000	.54263	.55998	2.84002
Equal variances			3.133	17.451	.006	1.70000	.54263	.55741	2.84259

Table 4. The correlation of the existing and the proposed algorithm with p-value where N=20 and significance value from the statistical analysis tool.

Pair 1	**N**	**Correlation**	**Significance Value**
Mean Filter & Median Filter Algorithm	10	.629	0.456

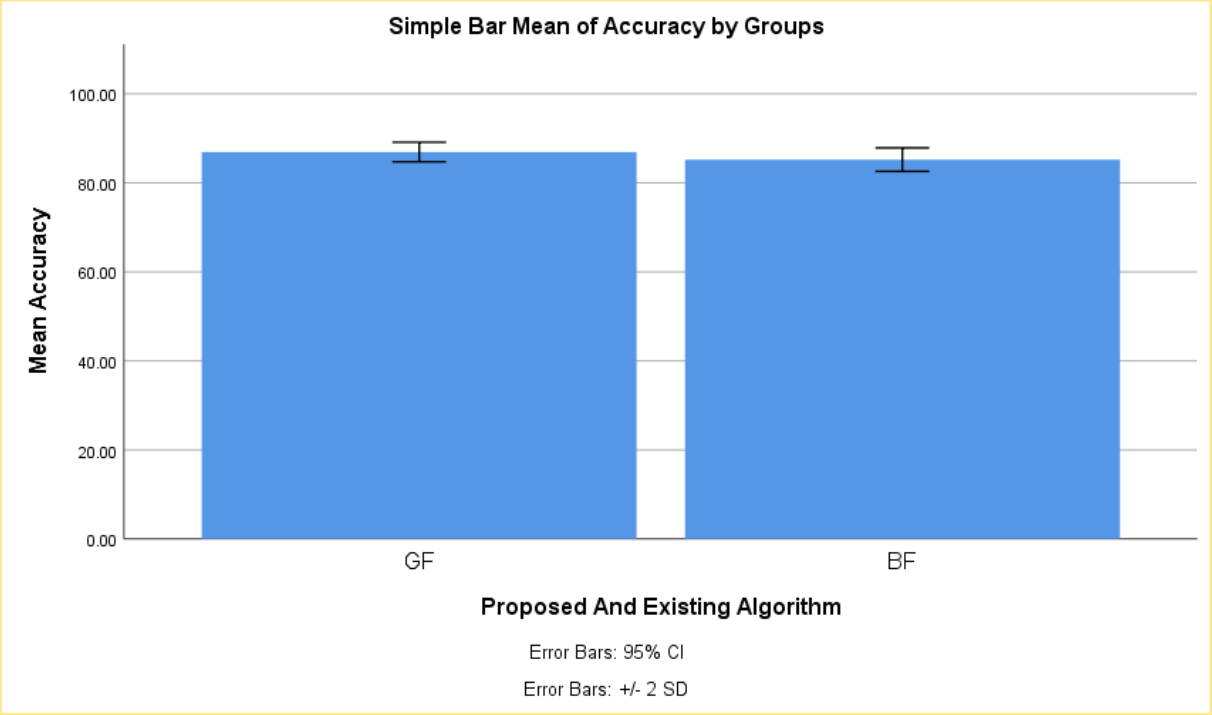

Fig. 1. Bar chart representation of the comparison of mean accuracy of the proposed and the existing algorithm. The accuracy of the prediction of the proposed algorithm is found to be 86.9% and the proposed algorithm gives better results compared to the existing algorithm that has accuracy of 85.2% the mean accuracy detection is ±2 SD.