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

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Abstract

Aim: The research aims at performing noise removal in capturing wildlife photography by applying Gaussian Filter with improved accuracy compared to Gabor Filter technique.
Materials and Methods: The study contains application of Gabor filter and Gaussian filter 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 Gabor Filter algorithm with 90.5% while the Gaussian filter algorithm has shown an accuracy of 86.9%. The mean value is 90.5, mean accuracy detection is ±2SD and the significant value is 0.000 ($p<0.05$) which shows the hypothesis is correct and it is carried out using an independent sample T test.
Conclusion: The final outcome of the Gabor Filter (90.5%) algorithm is found to be significantly more accurate than the Gaussian Filter algorithm (86.9%).

Keywords: Novel Image Denoising, Gabor Filter, Gaussian Filter, Texture Analysis, Edge correction, Image Smoothing.

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1. Introduction

Novel Image Denoising is Technique used in (Srbic 2015) Image Processing Systems for removing noise effects that affect the quality of Image and application of the system used in Photography, Medical Imaging systems and Transmission networks, (G. He et al. 2022; Migliavacca 2019) etc. Image processing is classified into Analogue and Digital. Here our research deals with Denoising filter Models in Digital Image Processing systems. Some Known image processing techniques are Image Restoration, Linear Filtering, Image Smoothing and Matching Templates, (Zhang and Hancock 2006) Image Generation, (Schennach and Gunsilius 2019) Pixelation, Independent component analysis, Hidden Markov models, Anisotropic diffusion.

There are about 750 articles from various sources such as Google Scholar, IEEE Xplore and Springer. For performing Denoising in image (Oecd and OECD 2018) processing systems certain filter model algorithms were developed to achieve Sharpness of image, Edge protection, Image Smoothing (L. He and Wang 2018), Blur process , Resolution upgradation and so on. Few known Filter Models are Mean Filter (Bhanja et al. 2018) , Median Filter, Gaussian Filter, Bilateral Filter, Gabor Filter, Wiener filters and on the go (Singh et al. 2020). Here we deal with models which perform Novel image denoising on various images that are affected by Speckle noise, Salt and pepper Noise, random fluctuation of photons , Gaussian noise, Novel Image Denoising etc.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 capturing wildlife photography by applying Gaussian Filter with improved accuracy compared to Gabor Filter technique. This article supports the (G. He et al. 2022) development of visual systems with image analysis. It uses a gaussian function along with a modulated sinusoidal (Hague and Buck 2015) wave plane for carrying out noise filter processes on images. Gabor filter had its application in Image recognition, eye recognition systems, (Fang et al. 2022) optical character reading, fingerprint analysis, etc. where as Gaussian filter applies frequency filter techniques with discrete equations such as standard deviation along with window function for performing image smoothing, adding blur effect in graphic systems, thereby reducing details present in image source. Edge correction by gaussian filter is not accurate compared to Gabor Filter using Novel Image Denoising which is the research gap for the work. Gabor Filter is a linear Filter applied for texture analysis using image smoothing (Oppenheim and Verghese 2016).

2. Materials And Methods

This research work was carried out in the Department of Artificial Intelligence Laboratory of Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences. The dataset utilized for the proposed and existing algorithms is cars dataset which consists of 4500 images which was downloaded from www.kaggle.com. Two Groups were added in this paper and the 1st group is Gabor Filter algorithm (Yang and Fang 2018) with 92% while the 2nd group is Gaussian filter algorithm which has accuracy of 88%. There are about 108 samples in which 54 belong to the first group and the remaining 54 belong to the second group with g power as 82% along with confidence interval as 95% and enrollment ratio is set to be 1.

Unnecessary Images are cleaned by removing them from the dataset. For installation of the software a minimum of 160GB hard drive space is required and to download all the needy files for installation. In addition to that 6GB RAM is required to run the software smoothly without any interruption combined with the i3 processor to make sure that all the processes are executed parallely. And a 2GB graphics card is enough so that results are generated simultaneously for recognizing objects. The framework specified runs in Kaggle online development environment.

Gabor Filter Algorithm

Gabor filters are used widely in Image Processing for deep extraction of texture analysis and segmentation processes. So it attains good image orientation with Texture preservation and edge correction over Gaussian Filter. Gabor Filter in combination with Gaussian functions allows various frequencies to achieve better image analysis . Gabor Filter and Novel Image Denoising is designed for performing rotations and dilations, Scaling for better orientation of images. Steps for constructing Gabor Filter were provided in the following lines.

Step 1: Read Image for carrying out analysis. Source Image as IMG

Step 2: Define Mathematical constants for π(PI), λ(Lambda) , θ(Theta), Σ (Sigma), γ

Step 3: Assign separate variables to obtain mean value from Standard deviation for Neighbor

Step 4: Pass the value from **Step3 to the Gabor** function .

Step 5: Obtain values from functions abs(), Ceil(), Sin(), Cos()

Step 5.1: Pass Mean values to Abs() function which returns the absolute value of a pixel.
Step 5.2: Perform Product operation on Mean value , Value from Abs()
Step 5.3: function and angle value from Sin(), cos() functions respectively.
Step 6: Call arrange() function to perform texture analysis from the pixel obtained from Step 5.2
Step 7: Assign variables for x,y coordinates to get values from Sin() and Cos() function
Step 8: Pass the Parameters obtained to Gabor function and mathematical constants in Step2.
Step 9: Return Gv gabor function value obtained finally
Step10: Repeat Process until Texture and rotation process performed to denoise image given.

Gaussian Filter Algorithm
Gaussian is a Linear type filter designed with gaussian function .Gaussian Blur is produced as a result of this filtering model. It has its application in Graphic Systems for modifying image texture Edge correction details are hidden that were present in the Image source. Here steps for designing gaussian filter model is shared below

Step 1: Initialize the process by passing image source .
Step 2: Pass the coordinates of Image source x,y Sp(x,y)
Step 3: Read the values of pixels from Sp(x,y) parameters present within image source
Step 4: Perform Standard Deviation Ds () of Pixel nearby present in the window Ws
Step 5: Compute Mean values returned from distribution of Functions in Step4
Step 6: Declare function for storing value from frequency domain equations
Step 7: Fg. Return the Fg value with mean values of Pixel replacement
Step 8: Perform Product operation between value obtained in Step4 and Step 6
Step 9: Final product of Step 7 is Denoised image

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 Gabor 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 Gabor 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. 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 90.5%.
Table 1 shows the comparison of the accuracies of Novel Gabor Filter algorithm and Gaussian filter algorithm for a sample size of N=10.
Table 2 depicts the group statistics which shows the mean accuracy percentage is 90.5% and the standard deviation is 0.80417 for the sample size N=52 whereas the mean accuracy percentage is 86.9% with standard deviation as 1.07540 for sample size N=52.
Table 3 describes an independent sample T-test with confidence level 95% which compares the Gabor Filter algorithm and Gaussian filter algorithm.
Table 4 shows the bivariate correlation of the accuracies of the both Novel Gabor Filter algorithm and Gaussian filter algorithm where it has a correlation as 0.45.
Fig 1 shows the comparison of the mean accuracy of both Gaussian filter algorithm as well as Gabor Filter algorithm along with their error bars taking groups on X-axis and accuracy on Y-axis. The accuracy of the Gaussian filter algorithm is 86.9% while the accuracy of the Gabor Filter algorithm is 90.5%.

4. Discussion

Based on the result, Gabor Filter (90.5%) appears to be better than the Gaussian Filter Algorithm (86.9%). The values of the Mean filter are analyzed statistically and the difference is found out by plotting the graph against the algorithms.
Similar findings related to Gabor Filter (Rahaman 2016) algorithm is significantly efficient in texture analysis , scaling of images, rotation of Image smoothing (Rahaman 2016; Braunstein et al. 2020) without affecting source data compared to the existing algorithm, the dataset containing a large number of images is given as input into both the algorithms, and the accuracy rate of prediction is obtained for the existing and the proposed algorithms. Gabor Filter uses various frequency levels (Postal 2019) along with Gaussian function and it uses complex image sources thereby making Implementation cost too high in Edge corrections and may consume more (Agency and European Space Agency 2018) time for texture analysis and scaling of images.

The limitation of this system is that more cost for filtering techniques along with components used in designing the Filter Model during noise removal. In the future, the Gabor filter technique and Novel Image Denoising will have its application in studying Medical Imaging Systems, Geographical Data analysis, Radar Imaging systems (Fichtelberg 2016), Surveillance Image Recognition systems and Neural Analysis.

5. Conclusion

The research study found that the proposed Gabor 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 90.5%, and hence using the proposed algorithm gives better results compared to the existing algorithm that has accuracy of 86.9%.

Declarations

Conflicts 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 Gabor Filter algorithm and the Gaussian Filter algorithm with accuracy rate 86.9%.

S.No	**GABOR FILTER**	**GAUSSIAN FILTER**
1.	91	86
2.	90	86
3.	92	88
4.	88	88
5.	88	86
6.	92	87
7.	92	87
8.	89	87
9.	92	88
10.	91	86

Table 2. Group statistics T-Test for existing algorithm GaussianFilter (86.9) and Gabor Filter Algorithm (90.5) with the sample size 10. There is a statistically slight difference in the SD accuracy of the two algorithms. The Gabor Filter algorithm had the highest accuracy(1.64992) and the Gaussian Filter (0.87560).

Pair 1	**N**	**Mean**	**Std.Deviation**	**Std.Mean Error**
Gaussian Filter	10	86.9000	.87560	.52175
Gabor Filter	10	90.5000	1.64992	.27689.

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	6.290	.022	6.095	18	.000	3.60000	.59067	2.35905	4.84095

Equal variances			6.095	13.697	.000	360000	.59067	2.33051	4.86949

Table 4. The correlation of the existing and the proposed algorithm with p-value where N=10 and significance value from the statistical analysis tool.

Pair 1	**N**	**Correlation**	**Significance Value**
Mean Filter & Median Filter Algorithm	10	.192	.595

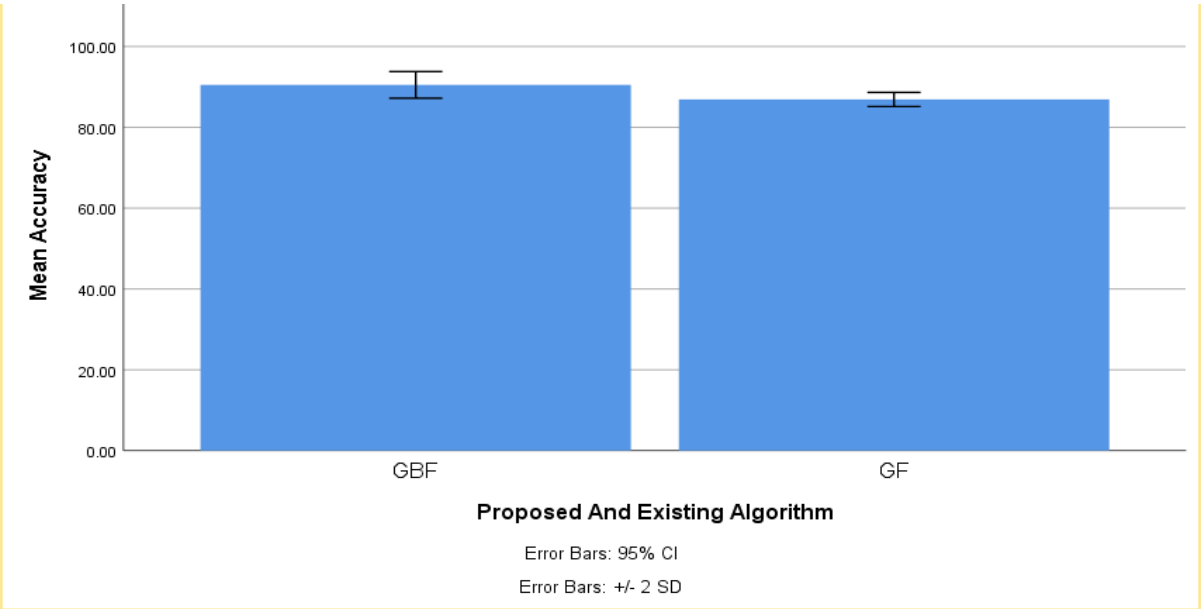

Fig. 1. Bar chart representation of the comparison of mean accuracy of the proposed and the existing algorithm. The accuracy of the prediction of the proposed algorithm is found to be 92% and the proposed algorithm gives better results compared to the existing algorithm that has accuracy of 88% the mean accuracy detection is ±2 SD.