RESEARCH ARTICLE OPEN ACCESS

A NOVEL IMAGE PROCESSING FILTERS FOR IMAGE DENOISING

MR.D JAYANAYUDU*, G DIVYAVANI **, R DILEEP ***, P BHARGAVA REDDY ****,

P GURUPRASAD YADAV*****

(Associate Professor, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India)1

(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 2
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 3
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 4
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 5
(Email.id: -dileeptiki@gmail.com)

--************************----------------------------------

Abstract:

This paper introduces a novel image denoising algorithm by combining multiple techniques to address the challenges posed by various types of noise in digital images. The proposed algorithm integrates the strengths of Wiener Filter, Homomorphic Filter, and Digital Filter. The combination of these techniques aims to provide a comprehensive and effective solution for image denoising. The Digital Filter can be used for purposes such as smoothing or sharpening, Wiener filter is used for noise reduction and Homomorphic Filter for brightness and contrast. We propose to develop an effective image denoising algorithm experimenting with a combination of Wiener Filter, Homomorphic Filter, and Digital Filter. We aim to craft an algorithm that optimizes validation metrics, carefully selecting and fine-tuning filters for their impact on enhancing image quality.

Keywords **—**Noise Reduction, Image Enhancement, MATLAB, Wiener Filter, Digital Filter, Homomorphic Filter

--************************----------------------------------

I. INTRODUCTION

Digital images are often corrupted by various types of noise during acquisition, transmission, or processing, posing significant challenges for subsequent analysis and visualization tasks. Image denoising, the process of removing unwanted noise while preserving essential image features, is a fundamental task in image processing. Traditional denoising methods, such as Gaussian smoothing or median filtering, have limitations in handling complex noise patterns without sacrificing image details. In response to these challenges, this paper presents a novel image denoising algorithm that integrates multiple techniques to effectively tackle diverse noise types encountered in digital images.

The principal objective of this project is to provide a novel picture denoising solution by integrating the advantages of three distinct filters: Wiener, Homomorphic, and Digital. This solution will be superior to the constraints of conventional techniques. These filters are complementary in that they can be used to handle various areas of picture improvement, brightness and contrast modification, and noise reduction. We hope to develop a strong and all-encompassing approach that can handle a variety of noise artifacts frequently present in digital photos by including them into a coherent denoising pipeline. Our objective is to develop an algorithm that yields aesthetically beautiful and analytically valuable results by removing noise while maintaining key image properties through rigorous experimentation and validation.

This project's scope includes a comprehensive investigation of noise reduction methods with an emphasis on integrating and fine-tuning the chosen filters to maximize denoising efficacy. Our method will be built to handle several noise types, which are frequently found in digital imaging applications, such as Gaussian, salt-and-pepper, and other abnormalities. In addition, we will tackle texture enhancement and edge preservation issues to guarantee that the denoised photos maintain crucial structural information and visual clarity. The suggested algorithm's efficacy will be impartially assessed using validation measures, which will also serve as a guide for fine-tuning to get the best denoising outcomes while upholding strict image quality requirements.

II. LITERATURE SURVEY

Valentina A. Baboshina, Anzor R. Orazaev, Evgenity D. Shalugin, and Aleksandr M. Sinitica [1] propose a method for effectively suppressing Gaussian noise in images through a combination of bilateral and median filters. This technique involves using the bilateral filter to smooth the image while preserving edges, followed by further noise reduction using the median filter, particularly effective against salt-and-pepper noise. Parameters such as filter diameters and standard deviations may require adjustment for optimal performance, and preprocessing steps like normalization or grayscale conversion can be applied. Post-processing techniques such as contrast enhancement can also be employed to improve visual quality, with evaluation metrics such as PSNR or MSE used to assess noise reduction success. Overall, this combined approach offers strong noise reduction capabilities while preserving image details.

Proposing a denoising method rooted in total variation, D. N. H. Thanh, S. D. Dvoenko, and D. V. Sang [2] emphasize minimizing pixel intensity fluctuations within images while retaining crucial features. Their iterative approach updates pixel values to diminish noise while preserving overall image structure, with total variation regularization targeting high-frequency components to promote smoother regions. Evaluation often involves metrics like PSNR or SSIM, affirming its robust denoising capabilities across diverse image types and noise levels. The method relies on iterative optimization techniques and careful parameter selection for efficacy. A critical aspect involves striking a balance between fidelity to the noisy input and the regularization term of total variation, ensuring optimal denoising outcomes. Continuing advancements in this approach.

D. N. H. Thanh, S. D. Dvoenko [3] Denoising biomedical images involves reducing or eliminating noise present in images acquired within the field of biomedicine. These images play a critical role in medical applications, including diagnosis and treatment planning. However, noise introduced during acquisition or from various sources can distort the images and hinder accurate interpretation. Denoising techniques aim to improve image quality by minimizing noise while preserving essential features and structures. This enhancement facilitates analysis, measurements, and diagnosis by medical professionals. Various methods, such as bilateral filtering or advanced image processing techniques, can be employed based on the type of noise and biomedical image characteristics. Ultimately, the goal is to enhance the reliability and utility of biomedical images for medical decision-making and scientific research.

T. G. Altundoğan, M. Karakose [4] The noise reduction technique employs dynamic fuzzy cognitive maps (DFCM) to enhance vehicle traffic camera images. Initially, preprocessing normalizes and readies input images for denoising. DFCM dynamically identifies noise patterns by analysing spatial and temporal characteristics. Through fuzzy inference, it determines denoising actions based on noise intensity and distribution. Adaptive filtering techniques selectively remove noise while preserving vital image features like vehicles and road structures. Iterative optimization refines denoising parameters for optimal performance. Evaluation metrics like PSNR confirm denoising effectiveness, with parameters adjusted to ensure robust noise reduction across diverse traffic scenarios. Real-time implementation facilitates on-the-go noise reduction for traffic management applications. Overall, the approach presents an adaptive and efficient solution for improving vehicle traffic camera image quality in dynamic environments

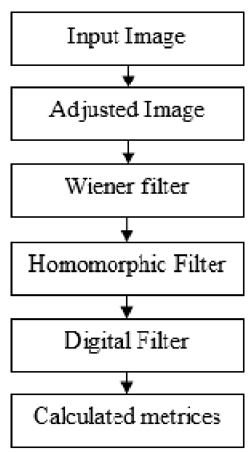
Caixia Liu and Li Zhang [5] have devised a denoising algorithm titled "A Novel Denoising Algorithm Based on Wavelet and Non-Local Moment Mean Filtering" (2021) with success. This algorithm effectively reduces noise in images by combining wavelet and non-local moment mean filtering techniques. Initially, the image undergoes decomposition using wavelet transform to extract its multi-resolution components. Subsequently, non-local moment mean filtering is applied to each wavelet coefficient to suppress noise while preserving image details. This filtering method computes weighted averages of neighbouring pixel values based on their similarity. Parameters such as filter size and threshold are fine-tuned to achieve optimal noise reduction. The algorithm iteratively updates pixel values to improve denoising performance. Evaluation metrics like PSNR are utilized to assess the algorithm's effectiveness. The approach offers a robust solution for denoising images with diverse noise levels and textures, with its real-time implementation facilitating practical applications requiring noise reduction.

III. PROPOSED SYSTEM

The proposed method for image denoising introduces a novel approach by integrating three distinct filters: the Wiener filter, Homomorphic filter, and Digital filters. These filters collectively target the challenge of Gaussian noise, a prevalent issue that significantly degrades image quality. The Wiener filter, renowned for its noise reduction capabilities, operates in the frequency domain, where it adapts its parameters to selectively attenuate noise while preserving essential image features. It provides a robust solution for removing Gaussian noise while maintaining image clarity.Complementing the Wiener filter, the Homomorphic filter plays a vital role in enhancing contrast and adjusting brightness across different regions of the image. Operating in the logarithmic domain, it effectively mitigates uneven illumination and enhances overall image quality. By addressing issues related to uneven lighting and contrast, the Homomorphic filter contributes to the comprehensive denoising process.

Additionally, the integration of Digital filters further enhances the versatility and effectiveness of the proposed solution. Digital filters, including median filters, Gaussian filters, and bilateral filters, offer a range of options for tasks such as smoothing, sharpening, and additional noise reduction. By incorporating these filters into the denoising pipeline, the method gains the flexibility to address specific artifacts or noise patterns that may persist after the application of the Wiener and Homomorphic filters.
The synergy between these three filters is the key strength of the proposed solution.

BLOCK DIAGRAM:



IMPLEMENTATION

1. **Input Image**: This represents the unprocessed original image, serving as the foundational starting point for all subsequent steps in the image processing pipeline.

2. **Adjustments**: Following the acquisition of the input image, adjustments are made to enhance or correct it. These adjustments may encompass modifications to brightness, contrast, or colour balance, tailored to improve the overall quality of the image.

3. **Wiener Filter**: Utilized for noise reduction and image enhancement, the Wiener filter is a pivotal technique aimed at reducing unwanted noise or artifacts while preserving important image features. It operates in the frequency domain, effectively enhancing the quality of the image.

4.**Homomorphic Filter**: Applied to normalize brightness and enhance contrast across the image, the homomorphic filter plays a crucial role, especially in scenarios with varying lighting conditions. By equalizing illumination levels, it contributes to the overall enhancement of image quality.

5. **Digital Filter**: This step involves the application of digital filters to further refine the image. Digital filters offer versatility, allowing for tasks such as smoothing or sharpening, tailored to specific image processing requirements.

6. **Calculated Metrics**: Finally, quantitative metrics are computed from the processed image. These metrics provide objective measurements related to various image features, such as edges, textures, or colour distribution, facilitating an in-depth analysis of the image's characteristics.

IV. Software Description

MATLAB:

The name MATLAB stands for Matrix Laboratory. The software is built up around vectors and matrices. This makes the software particularly useful for linear algebra but MATLAB is also a great tool for solving algebraic and differential equations and for numerical integration. MATLAB has powerful graphic tools and can produce nice pictures in both 2D and 3D. It is also a programming language, and is one of the easiest programming languages for writing mathematical programs. These factors make MATLAB an excellent tool for teaching and research.

IMAGE PROCESSING IN MATLAB:

In MATLAB, image processing encompasses the utilization of digital techniques to manipulate and analyse images, aiming to extract valuable insights or improve their visual fidelity. It involves applying a diverse range of algorithms and operations, including filtering, edge detection, segmentation, morphological operations, and feature extraction. MATLAB offers a comprehensive suite of dedicated functions and tools tailored for these tasks, making it a favoured platform among researchers, engineers, and developers in the field. Leveraging MATLAB's capabilities, users can undertake tasks such as image restoration, object recognition, enhancement, and medical image analysis. These capabilities contribute significantly to advancements in areas like computer vision, medical imaging, and remote sensing.

V. RESULTS:

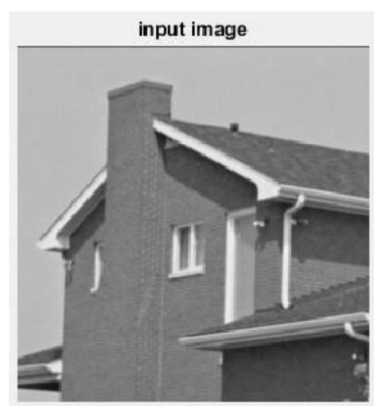


Fig: Input Image

This is the original, unprocessed image that serves as the starting point for all subsequent steps.

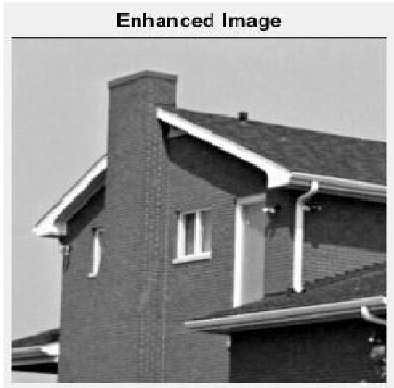


Fig: Enhanced Image

After capturing the input image, adjustments are made to enhance. These adjustments might include brightness, contrast, or colour corrections.

Fig: Wiener Filter Image

The Wiener filter is a technique used for noise reduction and image enhancement. It aims to improve the quality of the image by reducing unwanted noise.

Fig: Homomorphic Filter Image

The homomorphic filter is applied to normalize the brightness across an image and enhance contrasts. It is particularly useful for images with varying lighting conditions.

Fig: Digital Image

This step involves applying a digital filter to further refine the image. Digital filters can be used for various purposes, such as smoothing or sharpening.

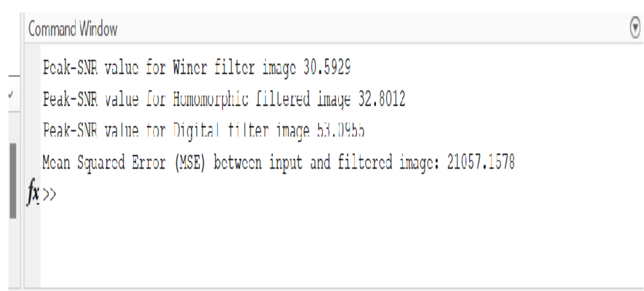


Fig: Command Window

TABLE: PSNR VALUES OF DIFFERENT MODELS

Image	Existing Method	Proposed Method
HOUSE	34.1681	53.0955
MONKEY	34.1660	53.7483
PLANE	35.0285	51.0245
STREET	32.0392	55.0660

VI. CONCLUSION

As a result, even while using bilateral and median filters together has the ability to reduce Gaussian noise in images, there are drawbacks, including the loss of subtle details, edge blurring, and inconsistent efficacy depending on the type of noise. It is still essential to strike a balance between the trade-offs of noise reduction and feature preservation in images. Additional investigation may delve into alternative methodologies or improvements to alleviate these limitations, guaranteeing more uniform and dependable denoising outcomes across a range of image processing assignments. To obtain the best results in image denoising applications, filter selection and parameter tweaking must be carefully considered.

VII. FUTURE SCOPE

In future, advancements in image denoising could explore hybrid approaches beyond Wiener, Homomorphic, and Digital Filters. Integrating deep learning techniques like convolutional neural networks holds promise for enhancement. Training neural networks specifically for denoising tasks with large-scale datasets could yield more effective algorithms. Optimizing for real-time denoising and hardware acceleration like GPUs or FPGAs could enhance processing speeds. Improving robustness to varying noise types, including Gaussian, salt-and-pepper, and speckle noise distributions, would be beneficialforpractical applicability.

VIII.REFERENCES

1. Valentina A. Baboshina, Anzor R. Orazaev, “Combined Use of a Bilateral and Median Filter to Suppress Gaussian Noise in Images’’2022 11th Mediterranean Conference on Embedded Computing (MECO)
2. D. N. H. Thanh, S. D. Dvoenko, and D. V. Sang, "A denoising method based on total variation," Proceeding of 6th international symposium on Information and Communication Technology SoICT, 2022, pp.223-230.
3. D. N. H. Thanh and S. D. Dvoenko, "A denoising of biomedical images," The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences (Photogrammetric techniques for video surveillance, biometrics, and biomedicine), vol. 5, XL-5/W6, 2022, pp
4. T. G. Altundoğan and M. Karakose, "A noise approach using dynamic fuzzy cognitive maps for vehicle traffic camera images," Zooming Innovation in Consumer Technologies Conference (ZINC), 2021, pp. 15-20.
5. Caixia Liu and Li Zhang, " A Novel Denoising Algorithm Based on Wavelet and Non-Local Moment Mean Filtering," Computers & Electrical Engineering, 2021, № 106783.
6. D. N. H. Thanh and S. D. Dvoenko, "A variational method to remove the combination of Poisson and Gaussian noises," Proceeding of the 5th international 101 workshop on Image mining: Theory and Application IMTA-5, 2022, pp.38-45.
7. J. Shen, H. Sun, H. Zhao, and X. Jin, "Bilateral filtering using fuzzymedian for image manipulations," 11th IEEE International Conference on Computer-Aided Design and Computer Graphics, 2021, pp. 158-161.
8. W. Cao, S, Wu, J. Wu, Z. Liu, and Y. Li, "Edge/structure-preserving texture filter via relative bilateral filtering with a conditional constraint," IEEE Signal processing letters, vol. 28, 2021, pp. 1535-1539
9. Yuqin Li, Ke Zhang, Welli Shi, Yu Miao and Zhengang jiang, “A Novel Medical Denoising Method Based on Conditional Generative Adversaries Network, 2021
10. R. C. Gonzalez, R. E. Woods, and S. L. Eddings, "Digital Image Processing using MATLAB," Gatesmark Publishing, 2021, p.1023.