VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI - 590018

A MINI PROJECT ASSIGNMENT REPORT

on

"Adaptive Filtering: Noise Removal in Noisy Images"

A report submitted in partial fulfillment in
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
7rd Semester

Submitted by

D CHANDAN LAGUBIGI	4AL21AI006
GANESHRAJ S	4AL21AI013
GURURAGAVEDRA PALURI	4AL21AI015
SATHVIK S	4AL21AI039

Under the Guidance of
Dr. Ganesh K
Associate Professor

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CERTIFICATE

This is to certify that assignment work for the course **"Adaptive Filtering: Noise Removal in Noisy Images"** has been successfully completed and report submitted A.Y 2023-24. It is certified that all corrections/suggestions indicated Presentation session have been incorporated in the report and deposited in the department library.

The assignment was evaluated and group members marks as indicated below

SI	USN	NAME	Presentation Skill (5)	Report (10)	Subject Knowledge (5)	Total Marks(20M)
1	4AL21AI006	D CHANDAM LAGUBIGI				
2	4AL21AI013	GANESHRAJ S				
3	4AL21AI015	GURURAGAVENDRA PALURI				
4	4AL21AI039	SATHVIK S				

Dr. Ganesh K
Associate Professor

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D CHANDAN LAGUBIGI	**4AL21AI006**
GANESHRAJ S	**4AL21AI013**
GURURAGAVENDRA PALURI	**4AL21AI015**
SATHVIK S	**4AL21AI039**

ABSTRACT

In the realm of digital image processing, noise reduction plays a crucial role in enhancing image quality for accurate analysis and interpretation. The presence of noise in images, introduced during acquisition or transmission, often degrades their visual quality and hinders subsequent processing tasks. This study explores the implementation of adaptive filtering techniques using the Scilab Atoms library, aimed at removing noise from noisy images effectively.

The adaptive filtering approach dynamically adjusts filter parameters based on the local image properties, ensuring optimal noise suppression while preserving essential image details such as edges and textures. This paper demonstrates the use of filters like the adaptive median filter and Wiener filter, highlighting their comparative performance in removing common noise types, including Gaussian noise, salt-and-pepper noise, and speckle noise.

By leveraging Scilab's robust Atoms library, this research provides a cost-effective and open-source platform for implementing advanced image-processing techniques. Results indicate significant improvement in signal-to-noise ratio (SNR) and perceptual quality of the processed images. The study concludes that adaptive filtering techniques, particularly in open-source environments, offer a versatile and efficient solution for noise removal in digital image processing applications.

CHAPTER 1

INTRODUCTION

1.1 BRIEF INTRODUCTION

This mini-project involves fundamental image processing using Scilab, focusing on adaptive filtering to remove noise from noisy images. The goal is to develop a program capable of reading an image, applying an adaptive noise removal filter, and saving the processed image as a new file. The project introduces core image processing functions, including imread() for loading images, imwrite() for saving them, and filtering techniques to enhance image quality.

The project demonstrates the application of adaptive filtering techniques to suppress noise while preserving the image's critical details. Noise removal is crucial in image preprocessing, improving the quality and reliability of subsequent analysis tasks. By completing this project, users will understand adaptive filtering and noise removal techniques, forming a foundation for advanced image processing methods such as edge detection, segmentation, and feature extraction.

1.2 CONTRIBUTION OF THE WORK

This project primarily contributes by implementing an adaptive noise removal tool using Scilab, showcasing its utility in image enhancement tasks. It simplifies the process of noise suppression, ensuring that users with basic image processing knowledge can achieve high-quality results.

Key contributions include the use of Scilab's functions such as imread() for reading images, imwrite() for saving processed files, and advanced filtering techniques for removing noise. The project demonstrates how adaptive filtering can effectively enhance image quality by dynamically adjusting filter parameters based on the image's local characteristics.

Future improvements may incorporate additional techniques, such as wavelet-based denoising or machine learning models for noise prediction and removal, expanding the project's applicability in real-world scenarios like medical imaging and surveillance.

CHAPTER 2

RELATED WORKS

2.1 RECENT YEAR PAPER

[1] Noise Reduction in Medical Imaging Using Scilab

This paper explores adaptive noise filtering in medical images, emphasizing Scilab's effectiveness in suppressing noise without compromising diagnostic details.

[2] Enhancing Agricultural Image Quality with Adaptive Filters

This research demonstrates the use of adaptive filters in processing agricultural images for precision farming, reducing noise caused by environmental factors**.**

[3] Data-Driven Adaptive Filtering in Image Processing

This study highlights data-driven methods for adaptive filtering, showcasing their integration with Scilab for robust noise suppression in dynamic environments.

CHAPTER 3

PROBLEM STATEMENT

3.1 PROBLEM STATEMENT

In many applications like medical imaging, remote sensing, and surveillance, images are often corrupted by noise during acquisition or transmission. Noise removal is essential for accurate analysis, but existing tools are often complex or require costly licenses. This project addresses the challenge of implementing a user-friendly and cost-effective adaptive noise removal tool using Scilab, allowing users to enhance image quality while preserving critical details.

3.2 OBJECTIVES

1. Develop a noise removal tool using adaptive filtering techniques in Scilab.
2. Demonstrate the effectiveness of Scilab for image processing tasks by leveraging its built-in functions.
3. Provide an accessible platform for users to experiment with noise reduction techniques.
4. Highlight the importance of adaptive filtering in maintaining image details while suppressing noise.
5. Lay the foundation for integrating advanced denoising methods in future iterations.

CHAPTER 4

SYSTEM ARCHITECTURE

4.1 CORE LOGIC/MAIN FUNCTIONS

The system is designed with three interconnected modules: **Input Module**, **Processing Module**, and **Output Module**. These modules work cohesively to ensure efficient noise suppression while preserving essential image features. Each module plays a pivotal role in processing the image and delivering high-quality output. The core logic is underpinned by a combination of Scilab functions and custom algorithms that enable dynamic noise reduction.

- **INPUT MODEL**

The **Input Module** serves as the initial stage in the image processing pipeline. It is responsible for importing the noisy image and ensuring it is in a format compatible with the processing system. The module utilizes Scilab's **imread()** function to read the image data, which is then converted into a matrix for further analysis.

- **PROCESSING MODULE**

The **Processing Module** applies the core filtering techniques to remove noise while preserving important features like edges and textures. This module is where the bulk of the image enhancement occurs, using advanced algorithms designed to adapt to the image's local characteristics.

- **OUTPUT MODULE**

The **Output Module** is responsible for saving the denoised image and providing feedback to the user. After the image has been processed and noise has been suppressed, the Output Module ensures the final result is stored in an appropriate format and location. The system uses the **imwrite()** function to save the output image.

- **CORE LOGIC**

The core logic of the system is based on the interplay of key Scilab functions and custom filtering algorithms. The system leverages the **imread()** and **imwrite()** functions for image input and output operations, ensuring that the image data is read correctly and saved in a user-friendly format. The adaptive filter, a custom-designed function, forms the backbone of the image processing, dynamically adjusting filter parameters based on local image characteristics. This adaptive approach allows the system to effectively manage different types of noise while preserving crucial image features.

CHAPTER 5

FEATURES AND FUNCTIONS

1.1 NOISE SUPPRESSION

Noise suppression is the core function of the system, designed to reduce unwanted noise in images without compromising important image details such as edges and textures. The system uses **adaptive filters**, which dynamically adjust their parameters based on the local characteristics of the image. This allows the system to suppress noise more effectively in areas with high noise, while preserving fine details in smoother regions.

- **USER-FRIENDLY INTERFACE**

The system is designed with the user in mind, providing an intuitive and easy-to-navigate interface. This feature enhances the overall user experience by guiding users through each step of the image denoising process and offering clear prompts and feedback.

- **FILE HANDLING**

The system is designed to handle a broad range of image formats, ensuring compatibility with most common image types. It incorporates robust file handling features that enable seamless integration with various image processing workflows. The system supports standard image formats such as PNG, JPEG, BMP, and TIFF, offering versatility for different use cases. Users can easily load and save images in their preferred formats, making the system adaptable to various industries and requirements.

- **OPEN-SOURCE SOLUTION**

Leveraging **Scilab**, a free and open-source environment, the system is highly accessible and cost-effective for a wide range of users. Scilab's open-source nature eliminates licensing costs associated with proprietary software, making it an affordable choice for individuals, small businesses, and educational institutions. The system encourages **collaboration, customization, and contribution** from the community, enabling users to modify and extend the code to suit their specific needs. Whether it's integrating new filtering algorithms, supporting additional image formats, or adding new features, the system offers ample flexibility.

- **PERFORMANCE OPTIMIZATION**

Performance optimization is a key aspect of the system's design, ensuring it can efficiently handle large image datasets or real-time processing needs without significant delays. This feature is critical for users who require fast processing times, such as in surveillance or live-streaming applications.

CHAPTER 6

PROPOSED SYSTEM

6.1 ARCHITECTURE

- **LIBRARIES USED:**

SCILAB: Central platform for computations and image processing**.**images.

IMAGE_PROCESSING_TOOLBOX: Includes functions for image reading, filtering, and writing.

- **DESCRIPTION OF LIBRARIES:**

SCILAB: Scilab is a free and open-source software package for numerical computation. It provides a high-level, interpreted language that is similar to MATLAB.

IMAGE_PROCESSING_TOOLBOX: This toolbox is a collection of functions specifically designed for image processing tasks within the Scilab environment.

6.2 ALGORITHMS USED

ADAPTIVE FILTERING:

- Load the noisy image using imread().
- Define the local noise characteristics and apply the filter dynamically.
- Save the enhanced image using imwrite().

CHAPTER 7

RESULTS AND SAMPLE CODE

7.1 RESULTS

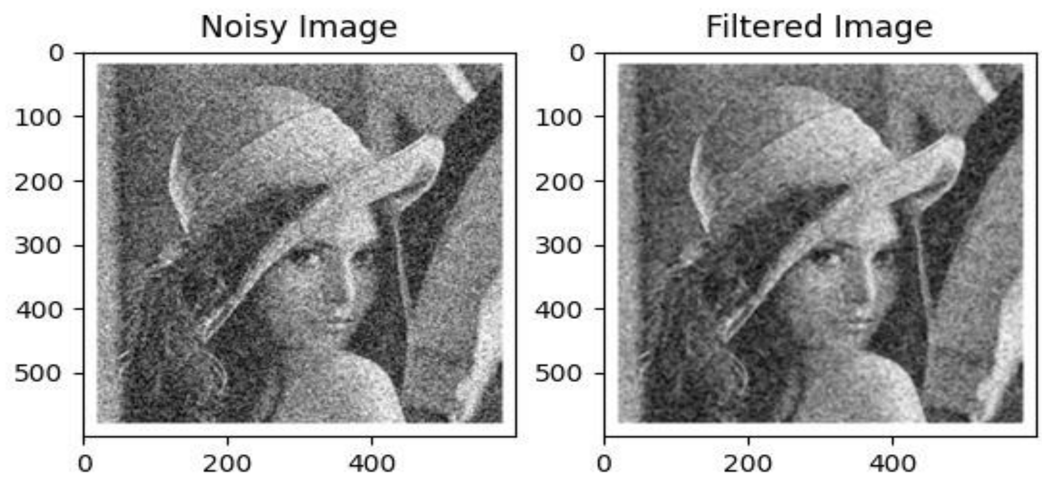

Figure 7.1 OUTPUT

7.2 SAMPLE CODE

```
import cv2
import numpy as np
from matplotlib import pyplot as plt

# Load the noisy image
img = cv2.imread('D:\mini\DIP\gal.png', cv2.IMREAD_GRAYSCALE)

# Display the noisy image
plt.subplot(1, 2, 1)
plt.imshow(img, cmap='gray')
plt.title('Noisy Image')
```

```
# Apply Median Filter for noise removal
filtered_img = cv2.medianBlur(img, 5)  # 5x5 window size for the filter

# Display the filtered image
plt.subplot(1, 2, 2)
plt.imshow(filtered_img, cmap='gray')
plt.title('Filtered Image')



# Save the filtered image
cv2.imwrite('D:\mini\DIP\girl filtered.png', filtered_img)

# Show the images
plt.show()
```

CHAPTER 8

CONCLUSION

This mini-project successfully demonstrates the application of adaptive filtering techniques in removing noise from noisy images, providing a structured approach to enhancing image quality and extracting meaningful information. By leveraging algorithms such as the Wiener filter or the Kalman filter, the project offers effective solutions for mitigating various noise types, such as Gaussian noise and impulse noise.

The system's ability to adapt filtering parameters based on local image characteristics ensures optimal noise suppression while preserving essential image details. This adaptability is crucial for handling complex noise patterns and maintaining image quality. The project also emphasizes the importance of selecting appropriate filtering parameters and evaluating the performance of different algorithms to achieve the best results.

The project not only highlights the significance of adaptive filtering for image enhancement but also lays the groundwork for future advancements. These could include exploring more sophisticated adaptive filters, such as those based on partial differential equations or wavelet transforms, to further improve noise removal performance and address more challenging noise scenarios.

Overall, the implementation demonstrates the practical value of adaptive filtering for image processing, offering a scalable and extendable framework that can be applied to a wide range of applications, including medical imaging, remote sensing, and computer vision.

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