IMAGE FILTERING AND ENHANCEMENT

Introduction

In the realm of digital image processing, the pursuit of pristine and visually appealing images is a continuous and evolving endeavour. With the proliferation of image acquisition devices and the growing importance of images in various fields, including medical imaging, remote sensing, computer vision, and multimedia applications, the need for effective image filtering and enhancement techniques has become more pronounced than ever. These techniques play a pivotal role in refining and optimizing image quality, thereby enabling the extraction of valuable information and the improvement of visual aesthetics.

This method explores the fascinating and indispensable domain of image filtering and enhancement, focusing on the utilization of MATLAB as a versatile and robust platform. MATLAB, a high-level programming language and environment, offers a rich set of tools for image manipulation, making it a preferred choice for researchers and practitioners in this field. Our study delves into a diverse range of image enhancement and filtering techniques, offering insights into both fundamental principles and practical applications.

Problem Statement - The problem lies in the need to address image imperfections and enhance image quality in various application domains. Images frequently suffer from issues such as noise, distortion, and inadequate contrast, which can hinder their interpretability and usability. Existing solutions often lack the combination of effectiveness and versatility needed to cater to diverse scenarios, demanding a comprehensive approach. Thus, the challenge is to develop robust and adaptable image filtering and enhancement techniques that can seamlessly integrate with the MATLAB environment, facilitating real-world applications in fields such as medical imaging, computer vision, and more.

Literature Survey

Sl No.	Title	Journal Publication	Abstract	Inference
1)	Unsupervised Low Light Image Enhancement Using Bright Channel Prior	IEEE, 2019	An unsupervised learning approach for single low-light image enhancement using the bright channel prior (BCP) that the brightest pixel in a small patch is likely to be close to 1. An un-supervised loss function is defined with the pseudo ground-truth generated using the BCP. An enhancement network, consisting of a simple encoder-decoder, is then trained using the unsupervised loss function. Furthermore, saturation loss and self-attention map is introduced for preserving image details and naturalness in the enhanced result.	The RetinexNet and the LightenNet over-enhance input images, making enhanced results unnatural. The DHN often loses image details, and thus the results do not contain vivid and natural colour. The results of UPE are more natural compared to other methods, but there is still a colour-inconsistency

				problem in some images. Contrarily, the method here preserves image details and naturalness well and maintains the colour consistency, while enhancing dark regions effectively.
2)	Low-Light Image Enhancement with Semi-Decoupled Decomposition	IEEE, 2020	In this paper, a novel Retinex-based low- light image enhancement method is addressed, in which the Retinex image decomposition is achieved in an efficient semi-decoupled way. Specifically, the illumination layer I is gradually estimated only with the input image S based on the proposed Gaussian Total Variation model, while the reflectance layer R is jointly estimated by S and the intermediate I. In addition, the imaging noise can be simultaneously suppressed during the estimation of R. During the	This low-light enhancement model can be easily adjusted to tackle low-light images with different imaging noise levels. Qualitative and quantitative

			decomposition process, the illumination layer is individually estimated based on the proposed Gaussian Total Variation filter, while the reflectance layer is jointly estimated based on the Retinex constraint.	experiments on four public datasets validate the effectiveness of this model.
3)	DSLR: Deep Stacked Laplacian Restorer for Low-light Image Enhancement	IEEE, 2020	In this paper, a deep stacked Laplacian restorer (DSLR) is proposed for low-light image enhancement. The key idea of the proposed method is to adjust the global illumination and restore local details by exploiting a Laplacian pyramid both in image and feature spaces. One important advantage of the proposed DSLR is that it has an ability to effectively preserve local details without significant colour distortions by using such connections of residuals learned in the multi-level Laplacian pyramid. A Laplacian pyramid based multiscale network, called a deep stacked Laplacian restorer (DSLR), for resolving the problem of low-light image enhancement. To make the learning process efficient, a multiscale Laplacian-residual block (MSLB) is used. This block plays an important role to improve the flow of information	Experimental results demonstrate that the proposed DSLR significantly improves the performance of low-light image enhancement (over 1.24dB in an aspect of PSNR) compared to state-of-the-art methods.

			based on abundant connections of higher-order residuals, which are defined in a multiscale structure of the embed- ding feature space, during the training phase.	

Literature Survey Summary:

Images acquired in the low-light environment are often degraded by poor visibility and low contrast. High-quality images can be obtained by increasing an exposure time, but this may incur blurs when a scene is not static. In order to solve this issue different papers used different methods. Some papers use the approach of unsupervised learning techniques, where the deep network is trained using BCP. The BCP imposes the constraint that the brightest pixel in a small patch of the enhanced image is close to 1. The BCP is used to generate an initial illumination map as pseudo ground-truth. This is the first attempt to enhance the low-light image through the unsupervised learning. Furthermore, a saturation loss and a self-attention map is employed to preserve an image naturalness even in the presence of bright regions in an low-light image. This enables the proposed network to avoid an over-saturation, while enhancing dark areas and preserving details in the resultant image.

Other papers approach the Retinex based image representation to enhance lowly illuminated portions of the image. In the Retinex theory, an original image S can be represented as the product of an illumination layer I and a reflectance layer R. Generally, the Retinex-based methods boil down to effectively solving the ill-posed I and R decomposition. On the one hand, the layer I represents the distribution of the scene illumination, and spatially determines the darkened regions in the scene. On the other hand, the layer R represents the material properties of the scene surface, and is assumed to be invariant. According to the above analysis, a modified Retinex model is introduced. Based on that, two-stage model is proposed to estimate I and R. First I is estimated via a proposed edge-preserving image filter based on Gaussian Total Variation (GTV). Then, R is estimated under the Retinex constraint, as well as a regularization term on R for dealing with the imaging noise N. By alternatively implementing these two stages, I and R are gradually refined until convergence, and the possible imaging noise N can be simultaneously suppressed during the refinement of R.

Another approach that can be taken is using the Deep Stacked Laplacian restorer (DSLR). The key idea is to adjust the global illumination and restore local details by exploiting a Laplacian pyramid both in image and feature spaces. Specifically, such two tasks are separately trained in different streams of the encoder- decoder architecture, which are defined by decomposition of the Laplacian pyramid, and corresponding outputs are progressively combined to reconstruct the enhancement result of the input image.

Pert Chart:

Week No	1	2	3	4	5
Problem Statement	✓				
Literature Survey	✓				
Design (Code)		✓			
Code Implementation			✓		
Experimentation				✓	
Result and Report					✓
Presentation					✓

Feasibility

The feasibility of conducting research on image filtering and enhancement using MATLAB depends on several factors.

Technical Resources: MATLAB is a widely used and accessible platform for image processing. It offers a broad array of built-in functions and toolboxes specifically designed for image enhancement. Therefore, technical resources are readily available, making the project technically feasible.

Expertise: To conduct this research effectively, you'll need a team with expertise in MATLAB programming and image processing. If you have access to individuals with the required skills or can develop them, it enhances the feasibility.

Data Availability: The availability of appropriate image datasets is crucial for testing and evaluating your image enhancement techniques. Access to relevant datasets might influence the feasibility of your research.

Time and Budget: Consider the time and budget available for your research. Developing and testing image enhancement algorithms can be time-consuming, and you may need resources for data acquisition, hardware, and software licenses.

Research Goals: Define clear research goals and objectives. Make sure they are realistic and attainable within the given time and resource constraints. This will impact the feasibility of your project.

Literature Review: A thorough literature review will help identify existing methods, gaps in the field, and potential areas for contribution. Ensure that your proposed research aligns with the current state of the art.

Ethical Considerations: If your research involves sensitive or private data, ethical considerations may affect feasibility. Ensure that your research adheres to ethical guidelines and data privacy regulations.

Collaboration: Collaboration with peers, mentors, or experts in the field can enhance the feasibility of your research by providing guidance, resources, and validation of your work.

OBJECTIVES

- To provide an overview of image filtering and enhancement techniques, including but not limited to noise reduction, contrast enhancement, sharpening, and feature extraction.
- To present practical implementations of these techniques using MATLAB, highlighting the ease of integration with this powerful software platform.
- To assess the effectiveness and performance of various image filtering and enhancement methods through experimentation and comparative analysis.

- To demonstrate the real-world applications and implications of these techniques in fields such as medical imaging, surveillance, and computer vision.

Proposed work:

- Algorithm Development: We will design and implement novel image processing algorithms that effectively address various image quality issues, leveraging the extensive capabilities of MATLAB.
- Integration with MATLAB: Our work will focus on seamless integration with the MATLAB environment, ensuring user-friendly and versatile tools that are accessible to a wide range of users.
- Performance Evaluation: We will rigorously evaluate the proposed techniques through experimentation, comparing them with existing methods to assess their effectiveness in diverse real-world scenarios.
- Application Demonstrations: The proposed work will showcase practical applications in fields such as medical imaging, surveillance, and computer vision, highlighting the impact of the developed image filtering and enhancement techniques.
- User-Friendly Tools: The final outcome will be user-friendly tools and software packages that facilitate the implementation of image processing solutions in MATLAB, empowering researchers and practitioners in various domains.

References

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- DIPUM Toolbox for MATLAB. (Year). [URL] - An online resource with code and examples for image processing in MATLAB, offering practical guidance on implementing image enhancement techniques.
- Smith, J., & Jones, A. (Year). "An Adaptive Noise Reduction Technique for Low-Light Images." Journal of Image Processing, Vol. 30, No. 4, pp. 512-527. - A research paper that explores noise reduction techniques for low-light images, which may be relevant to your work.
- MathWorks. (Year). "Image Enhancement Techniques in MATLAB." [URL] - An online resource from MathWorks that provides insights and practical guidance on image enhancement techniques using MATLAB.