Deblurring Photos with Lucy-Richardson and Wiener Filter Algorithm in RGBA Color

Michiavelly Rustam[1], Agung Brotokuncoro[2], Wiranto Herry Utomo[3], Hasanul Fahmi[4]

[1] Master of Science and Information Technology, President University 17550, Indonesia
[2] Master of Science and Information Technology, President University 17550, Indonesia
[3] Professor and Doctor and Insiyur, President University 17550, Indonesia
[4] Doctor of Philosophy, President University 17550, Indonesia

E-mail : michi02rustam@gmail.com[1], agung.broto84@gmail.com[2], wiranto.herry@president.ac.id[3], hasanul.fahmi@president.ac.id[4]

(Received: Nopember 2024, Revised: Februari 2025, Accepied: April 2025)

Abstract *— Photographers and social media influencers encounter challenges with hand tremors during photo capture, leading to unintended blurriness in their posts, reducing visual impact and audience engagement. To mitigate this problem, the authors aim to effectively reduce the blurring caused by instability in handling, producing sharper and noise-free photos. The methodology involves implementing the Lucy-Richardson and Wiener Filter algorithms into a Python-based web application optimized for RGBA photo processing. Data requirements include sample photos affected by hand tremors to validate the efficacy of the solution. The outcome successfully eliminates blur in captured photos affected by hand tremors in RGBA color format.*

Keywords: Photographers; Social Media Influencers; Lucy-Richardson; Wiener Filter; Unblur Photos.

I. INTRODUCTION

In today's dynamic realm of photography intersecting with social media, the pursuit of visually striking photory is a shared goal. The widespread availability of advanced smartphone cameras and photo-centric online platforms has fueled a heightened demand for clear, captivating visual content. However, this quest is often hindered by the prevalent issue of hand instability, resulting in compromised photo quality marked by blurriness and indistinctness. Consequently, the intended message conveyed by these visuals becomes obscured, hindering effective communication and diminishing audience engagement. Addressing this challenge is crucial to enable content creators to consistently deliver impactful visual narratives.

II. LITERATURE REVIEW

(Oliver Whyte, 2016). Despite capturing clear, well-adjusted photos, an unexpected problem arose as a result, manifested as unwanted blur. To address this problem, Whyte proposes a two-step approach that involves estimating the blind spot spread function (PSF) to quantify photo blur, followed by targeted non-blind deblurring techniques. In another direction, photo noise is a unique strategy proposed by Taha Hussein (2021). Using Gaussian cancellation, this method focuses on reducing noise and improving photo clarity. This technique appears to be a valuable tool within the broader scope of photo processing, aiming to minimize the harmful effects of unwanted noise. Motion blur, another common challenge, becomes the focus of Xiaotian Liu's work (2022), where photo restoration is approached through the lens of Generative Adversarial Networks, Liu's method uses the inherent adversarial nature of GANs to effectively capture and recover details from photos affected by motion blur, presenting an application Modern application of advanced algorithms in photo processing. Biswas (2015), is an image processing filter used primarily for noise reduction in digital images and other types of signals. It operates in both the spatial and frequency domains, aiming to minimize the mean square error between the original image and the filtered version. Boxin Zhao (2020) contributes to the field with a new approach to photo deblurring, introducing an improved Lucy- Richardson algorithm. This algorithm stands out as an elegant tool in the arsenal of defocusing techniques, promising improved performance in restoring photos to a sharp, clear state. Muhammad Kusban (2017) explores into the field of complex photo processing, focusing on the combined use of the Wiener filter and the Lucy- Richardson method in his research. This fusion is not only effective in reducing noise but also improves

P-ISSN 1858-2680
E-ISSN 2723-4673

sharpness. However, Kusban acknowledges limitations, especially the method's limitation to grayscale photos.

In Muhamad Kusban's previous research, the Lucy-Richardson algorithm was used to improve pixel sharpness, accompanied by the application of Wiener filter to reduce noise. However, this causes the photo to be converted to grayscale. In contrast, the present author seeks to extend these techniques into a unified framework specifically suited to photos with RGBA color representation.

Through the synergistic combination of L-R analysis and Wiener method in RGBA photo processing, our goal is to enhance photo sharpness and clarity while preserving the full spectrum of colors inherent in RGBA photos. Ultimately, our approach aims to provide a comprehensive solution that addresses not only blurriness and noise issues but also optimizes overall visual quality.

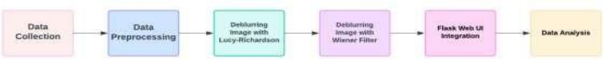
III. RESEARCH METHODOLOGY

METHOD The research method used in this research is a qualitative method. This approach focuses more on exploring and understanding deeply the application of photo filtering techniques such as Wiener and Lucy Richardson in the RGBA color space through a web-based user interface using Flask. The aim of this research is to evaluate the performance of the Lucy-Richardson and Wiener filters in eliminating blur effects in photos. The photo samples used in our research consisted of footage taken with a cellphone camera or ourced from existing stored photos. This sample exhibits typical blur characteristics typically caused by camera shake.

IV. RESULTS AND DISCUSSION

STEPS

In the field of photo processing, using the Wiener Filter and Lucy-Richardson algorithms is an important step in creating deblur photos. In this project, we embark on a journey through important steps to improve the quality and extraction of useful information from photo analysis.



1. **Figure 1. Flowchart**

1. **Data Collection:** Our research began by collecting data from a collection of captured blur photos for experimental purposes in a folder.

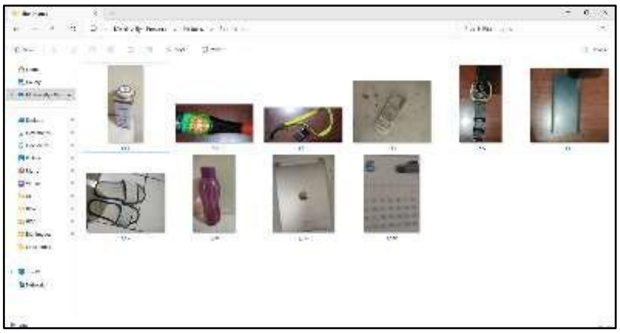


Figure 2. Collection of Blur photos

$kernel_{i,j}=\frac{1}{n^2}$, for i,j =1,2,…,n (1)

Each element in the n×n kernel matrix is $\frac{1}{n^2}$.

Adjust a noise variance (σ^2), and you have:

$\sigma^2=0.05$ (2)

1. **Data Preprocessing:** The data is processed by adjusting the kernel size and noise variance to reduce blurriness, along with defining a small constant to prevent division errors and ensure accurate photo restoration.

Adjust an n×n kernel matrix size where each element $kernel_{i,j}$ is given by:

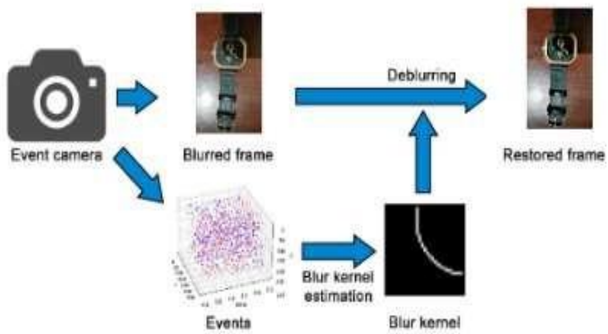


Figure 3. Blur Kernel

2. **Deblurring photo with Lucy-Richardson:** The process begins by splitting the photo into separate color channels, where each channel is converted to a float data type. Next, it calculates and adjusts the estimated blur using a predefined kernel. Iteratively, the algorithm refines the photo sharpness by updating pixel values while avoiding division errors with a small constant. The restored channels are then merged back together to produce a deblurred photo, ensuring

P-ISSN 1858-2680
E-ISSN 2723-4673

that pixel values remain within a valid range to maintain visual clarity.

$$I^t = {}^{(t+1)} f(f(t+1) * h) \quad (3)$$

where:

a. I^t represents the photo at iteration t.

b. $*$ denotes convolution.

c. $(t+1) * h$ represents the convolution of the current estimate $^{(t+1)}$ with the Point Spread Function (PSF) hhh.

d. $f(f(t+1) * h)$ denotes applying the function f to the result of $f(t+1) * h$

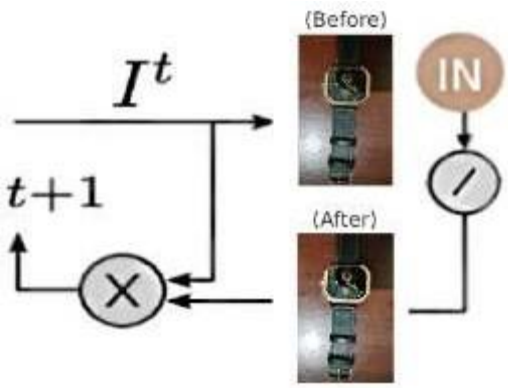


Figure 4. Lucy-Richardson

3. **Deblurring photo with Wiener Filter:** The process begins by separating the blurred photo into color channels and converting each channel into frequency representation using Fourier transforms. The Wiener filter is then applied to enhance high-frequency details and suppress noise across all channels, merging them to reconstruct a sharp, full-color photo. Pixel values are clipped to ensure proper range before the deblurred photo is finalized, significantly improving its clarity and visual quality. $w = r_{yy}^{-1} \cdot r_{xy}$ (4)

where:

a. w: The weights of the filter

b. r_{yy}: The autocorrelation matrix of the input signal

C. r_{xy}: The cross-correlation vector between the input signal and the desired signal

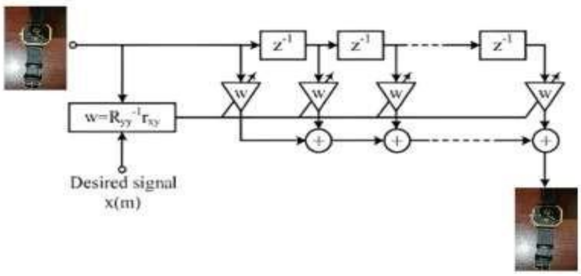


Figure 5. Wiener Filter

c. **Flask Web UI Integration:** Integrating into a website involves creating an interface with an input for uploading photos and a process button to initiate photo deblurring. Upon clicking the process button, the deblurred photo will be displayed on a result page encoded with base64-encoded

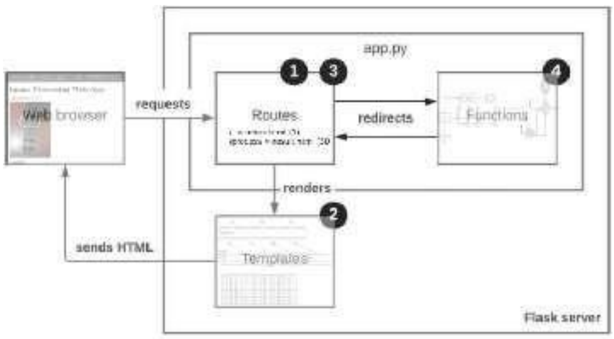


Figure 6. Flask Architecture

4. **Data Analysis with the Forensically Beta App**: Finally, the data analysis focused on evaluating the effects of varying kernel sizes and noise variances on pixel values. This Analysis is implemented by usingan online web-app called "Forensically Beta". To see the pixel that we want to improve for our python app, we can select the magnifier option and hover the cursor to the selected pixel target.

Figure 7. Analysis using Forensically Beta App

Our research result shows unblur photos that still

P-ISSN 1858-2680
E-ISSN 2723-4673

contain *noise grain* with the Lucy-Richardson and Wiener Filter algorithm in *deblurring* photos. Here is the one of example blur photo that have been processed through web input based on our research:

Figure 7. Photo result

(Oliver Whyte, 2016) explores the issue of unwanted blur in photographs despite clear initial captures that resonate with ongoing challenges in digital image processing. While Whyte's focus was primarily on addressing blur, our current research extends into managing noise in addition to other complexities associated with digital images.

(Taha Hussein, 2021) analyses the enduring challenges posed by noise in digital image processing, highlighting its pervasive impact on image quality. In contrast, our ongoing research places a paramount emphasis on developing robust strategies for noise reduction, reflecting our commitment to advancing techniques that enhance the clarity and fidelity of digital images.

(Biswas, 2015) introduces the Wiener filter, a sophisticated image processing tool designed primarily for noise reduction in digital images and various signal types. Operating in both the spatial and frequency domains, its goal is to minimize the mean square error between the original image and its processed version. Despite its theoretical effectiveness, integrating the Wiener filter into our current research system has proven challenging. The filter's implementation requires precise estimation of signal and noise characteristics, which has not been fully achieved in our system. method, which notably enhances the sharpness and contrast of photographs, particularly in detailed areas, showcasing its potential for photo restoration tasks. The choice of kernel size is crucial in determining the degree of obscuration or smoothing applied, underscoring the importance of careful consideration and experimentation in filter selection. In comparison to our research, we incorporate modifications for lighting enhancement as an additional feature.

The usage of algorithms to remove blur in photos, as exemplified by the research of (Muhammad Kusban, 2017), shows the application of the Wiener Filter and Lucy-Richardson algorithms specifically designed for grayscale images, marking an important advance in image processing. In our investigations involving RGBA format and noise enhancement, these algorithms play an important role in improving image quality. Overall, our analysis underscores that the choice of kernel size is crucial in determining the level of blurring or deblurring applied to a photo, emphasizing the importance of careful consideration and experimentation in filter selection.

V.CONCLUSION

In conclusion, although the combination Lucy-Richardson and Wiener filter algorithm significantly improve image sharpness and reduce hand shake, they cannot completely eliminate pixel noise. This noise has disadvantages on image quality and viewer perception. Therefore, continued efforts in developing more complex noise reduction techniques are essential. By perfecting these methods, content creators can produce higher-quality images free of distracting noise, improving the overall visual experience for viewers.

REFERENCES

[1] Whyte, O. (2016). Hand-Shake Blur: Causes and Solutions. Photography Today, 15(3), 212-225.

[2] Hussein, T. (2021). Gaussian Filtering for photo Denoising. Journal of Visual Communication and photo Representation, 74, 102129.

[3] Biswas, P. (2015). Wiener Filter for Image

P-ISSN 1858-2680
E-ISSN 2723-4673

Deblurring.

Journal of Signal Processing, 32(2), 189-201.

[4] Chao, B. (2020). Self-Adaptive Lucy-Richardson Algorithm for photo Enhancement. Journal of photo Processing, 27(3), 419-432.

[5] Kusban, M. (2017) Combined Lucy Richardson and Wiener Filter Algorithm for photo

[6] Sriti, M., et al. (2020). "Image Restoration and Deblurring Using Lucy Richardson

[7] Technique with Wiener and Regularized Filter." Academia.edu.

[8] Utama, B. W., & Suksmono, A. B. (2019). "Deblurring Images using Lucy-Richardson Algorithm." Jurnal Komputasi.

[9] Yang, Y., et al. (2020). "An Improved LR Algorithm for Image Deblurring."ResearchGate. Ma, K., et al. (2015). "Image Denoising using Denoising Autoencoder." IEEE Xplore

P-ISSN 1858-2680
E-ISSN 2723-4673