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Optimisation in image processing

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INTRODUCTION

Deblurring is the process of turning the **blurred image** into a **clearer image**. However, there are some deblurring methods that can't be used to deblur images. So, this project applies various **optimisation methods** to the blur images and recovers them into clearer images. The whole process is being done by **OpenCV-Python**.

OBJECTIVES

- Investigate and understand the challenges in deblurring images and the mathematical models that represent the deblurring problems.
- Recover the blurred image into a clearer image using the optimisation methods.
- Compare the effectiveness of deblurring between different optimisation algorithms.

METHODOLOGY

The steepest descent method, conjugate gradient method, and Barzilai-Borwein gradient method will be used in this project to solve the optimization problem in image processing. Armijo rule and Lipschitz inequality will be used to determine the step size of the algorithm. PSNR and SSIM will be used to evaluate the quality of the recovered image, the higher the value the better the image quality.

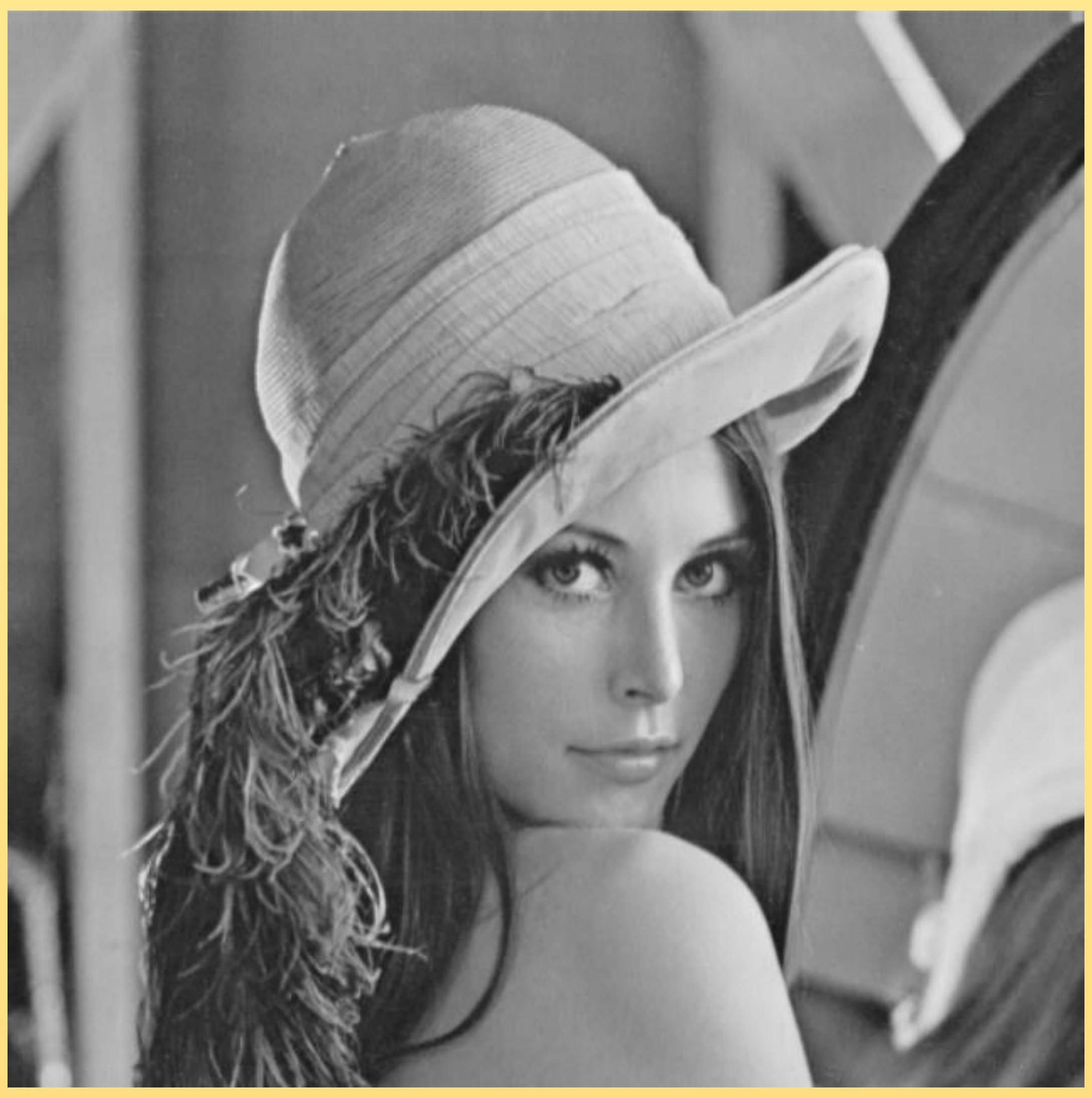


Figure 1: Original Image

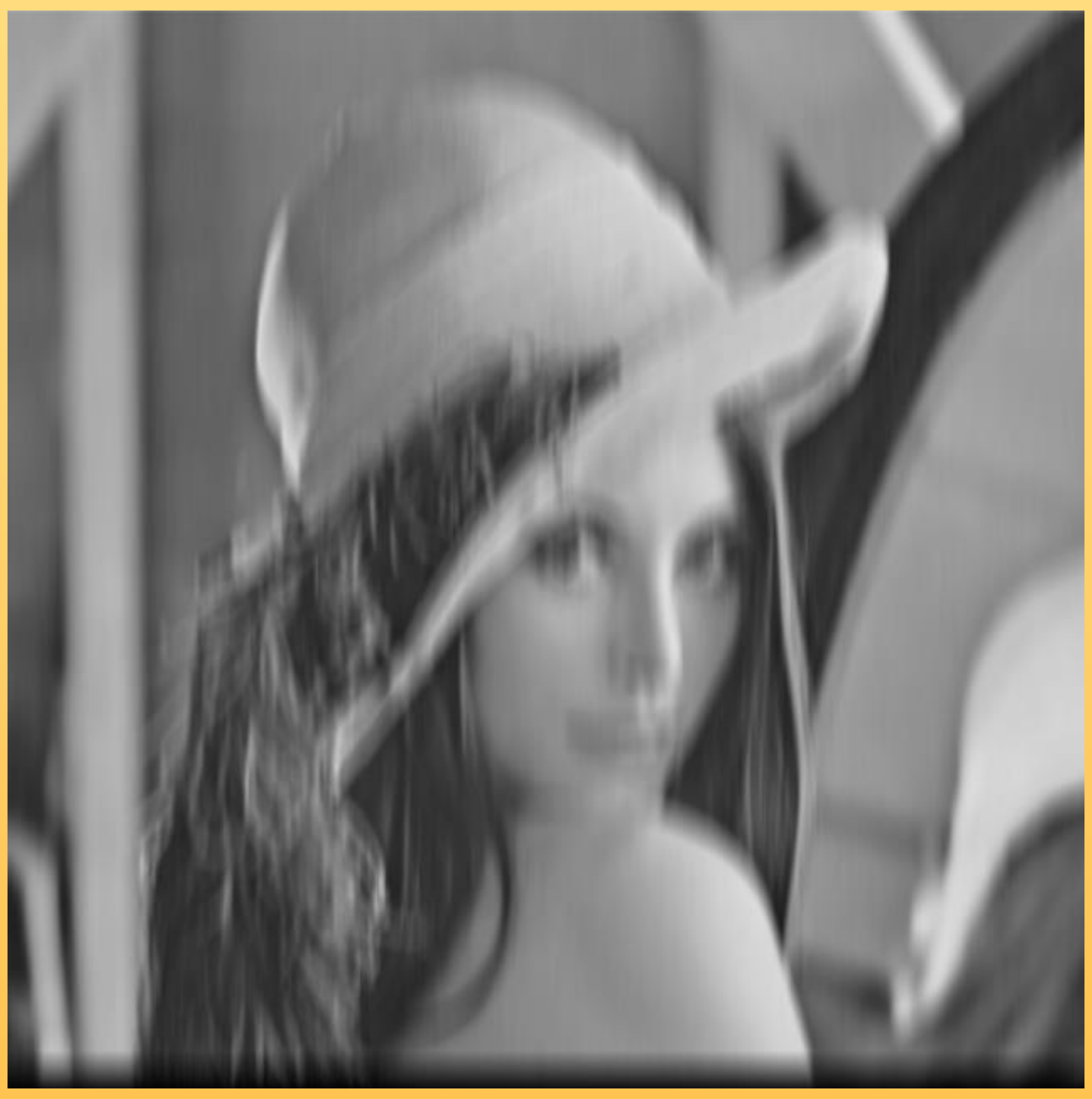


Figure 2: Blurred image with the dragging effect

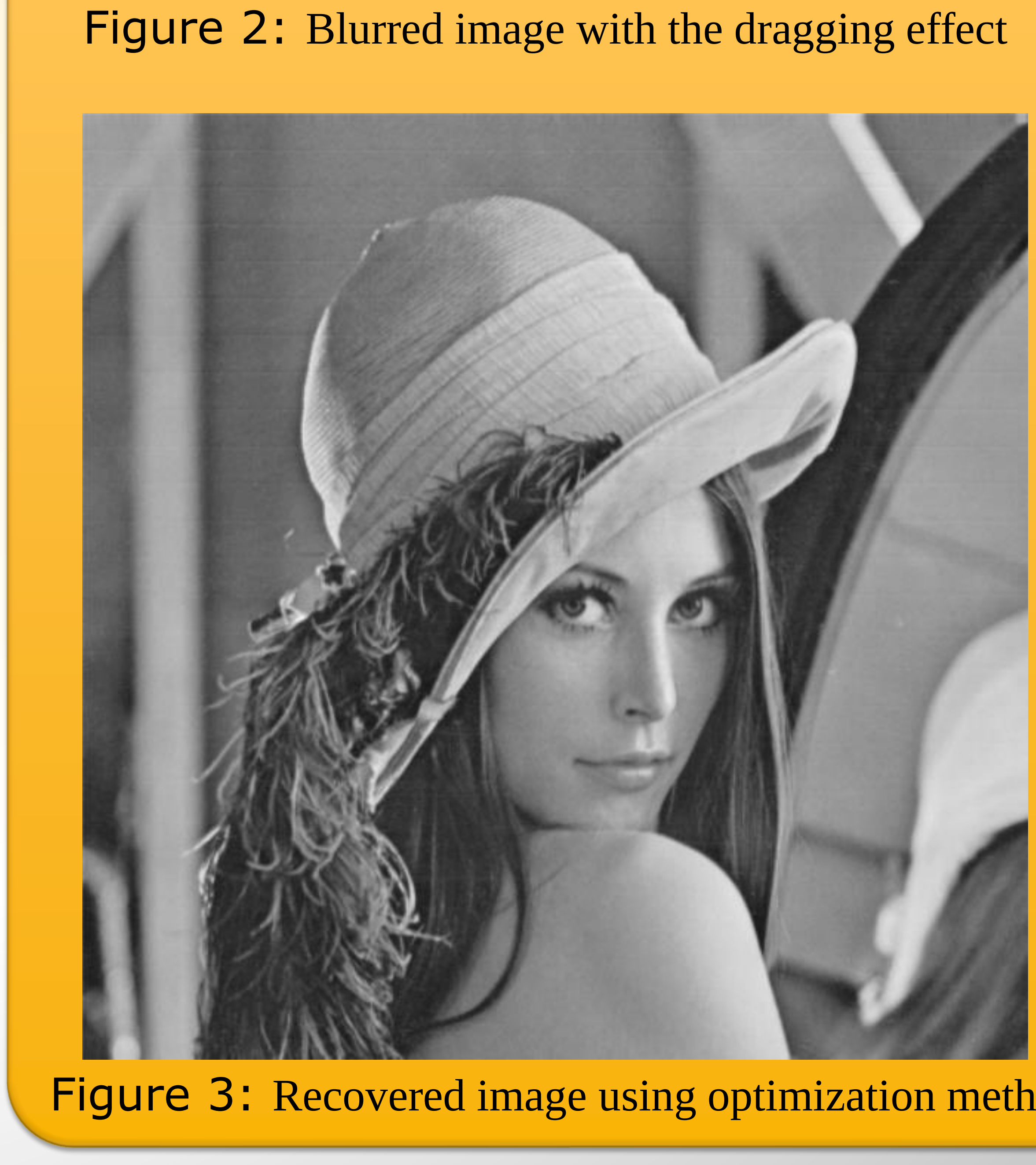
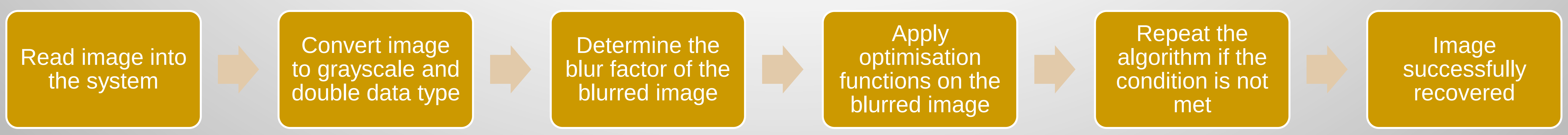


Figure 3: Recovered image using optimization method

RESULTS & DISCUSSION

Table 1: Results of recovered image compared to original image using different optimization methods from the best to the worst.

Algorithm to deblur image	PSNR	SSIM
Conjugate Gradient with Armijo	94.76158623	0.999999439
Barzilai and Borwein Gradient Method 2 with Armijo	93.59736804	0.999999208
Barzilai and Borwein Gradient Method 2 without Lipschitz or Armijo	93.59736804	0.999999208
Conjugate Gradient with Lipschitz	93.10939909	0.999999087
Barzilai and Borwein Gradient Method 1 with Armijo	92.0153788	0.999998565
Barzilai and Borwein Gradient Method 1 without Lipschitz or Armijo	92.0153788	0.999998565
Barzilai and Borwein Gradient Method 2 with Lipschitz	88.7204286	0.999995556
Barzilai and Borwein Gradient Method 1 with Lipschitz	88.15029473	0.999994752
Steepest Descent with Lipschitz	81.97649634	0.999978227
OpenCv-Python filter2D() function	67.53823251	0.998949032
Steepest Descent with Armijo	65.51771248	0.997308954



Read image into the system

Convert image to grayscale and double data type

Determine the blur factor of the blurred image

Apply optimisation functions on the blurred image

Repeat the algorithm if the condition is not met

Image successfully recovered

Figure 4: Flow of the deblurring process

CONCLUSION

Among the proposed algorithms, the Conjugate Gradient with Armijo rule gives the best result when it comes to recovering images.

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