COMP9517 – COMPUTER VISION
ASSIGNMENT 1 REPORT – T2 2022

by
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1. Stars Background Estimation and Removal

1.1 Introduction

Computer vision can be applied to assist in quantitative analysis of images. The aim of this task is to use image processing techniques to improve the visibility of stars from a snapshot of the night sky. The ideal result would be to remove the background artifacts of the image, leaving us with a black background with stars.

The algorithms used to achieve this were min-filtering, max-filtering, and pixelwise addition, and were implemented manually using for loops to iterate though the pixels.

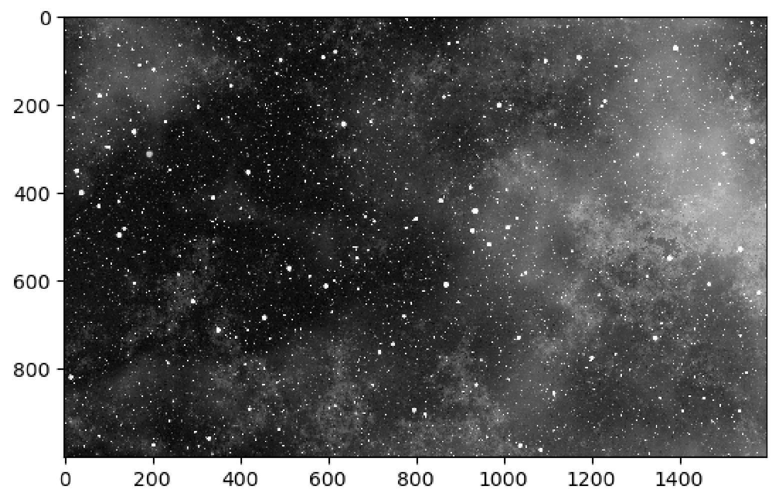

Image 1: Original image of Stars.png

1.2 Discussion of intermediate steps, results, observations

Firstly, min-filtering was used to remove all the stars from the image. By choosing the lowest intensity pixels in the neighbourhood N, the brightest pixels (Stars) were eliminated. However, this resulted in dark spots in areas where the background artifacts were not completely black, such as the right hand side of image 1.

Max-filtering was then used on the filtered image to eliminate the dark spots, this time assigning each pixel the highest intensity value in neighbourhood N. This effectively estimated the background of the image as shown in image 2.

Lastly, the image was put through a pixelwise subtraction with the estimated background to remove it. This was achieved by subtracting each pixel's intensity from the original image.

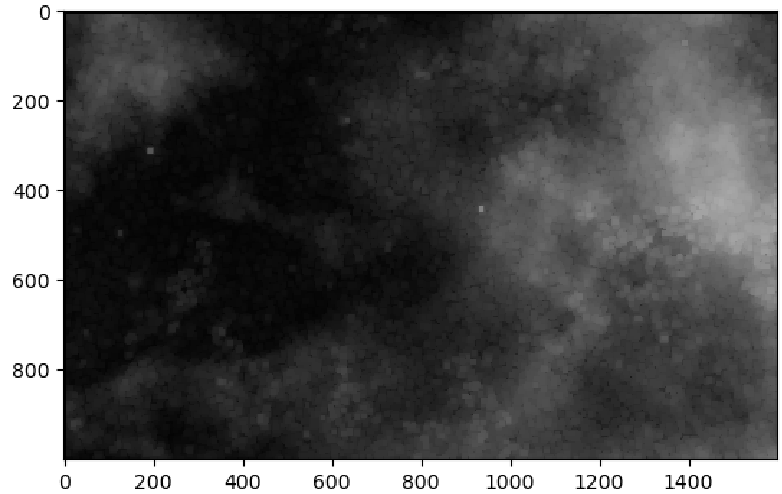

Image 1: Image after going through min and max filtering

The ideal value for parameter N was found to be 11 as it removed all of the background while maintaining the intensity of stars in the image. Lower values of N removed too many of the high intensity pixels resulting in a loss of stars in the output. However, the output also had the best background estimation when N=3.

Higher values of N would not estimate the background to a great enough detail as each pixel in the input image effectively translated to an NxN area.

The resultant output is shown below in Image 3.

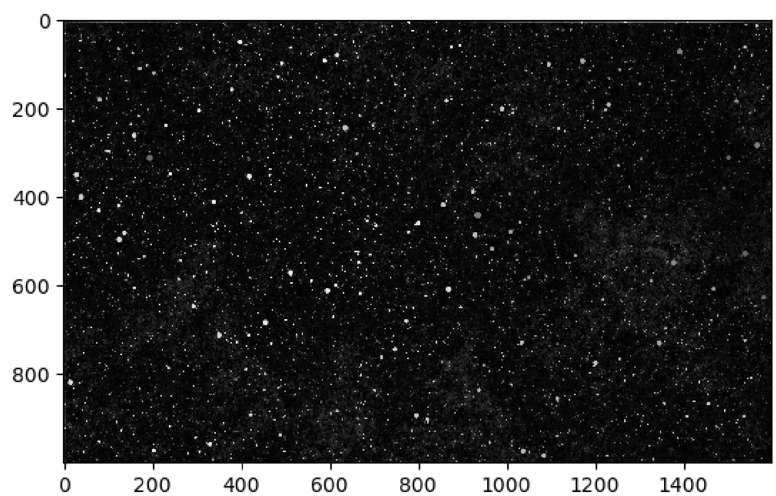

Image 3: Output image when N=11

2. CELL NUCLEI BACKGROUND REMOVAL

2.1 Algorithm Extensions

Several extensions to the algorithm had to be made to ensure that it was compatible with different images. Firstly, the size of the image was retrieved using the shape attribute of the cv2 image to allow the algorithm to be applied onto images of any size. The parameter N was also set at the start of the notebook such that any functions used will have the same neighbourhood size.

The most important extension to adapt the algorithm for the analysis of nuclei was a flag M, which made the algorithm perform max-filtering then min-filtering. The pixelwise subtraction operation also had to be adapted for the bright background.

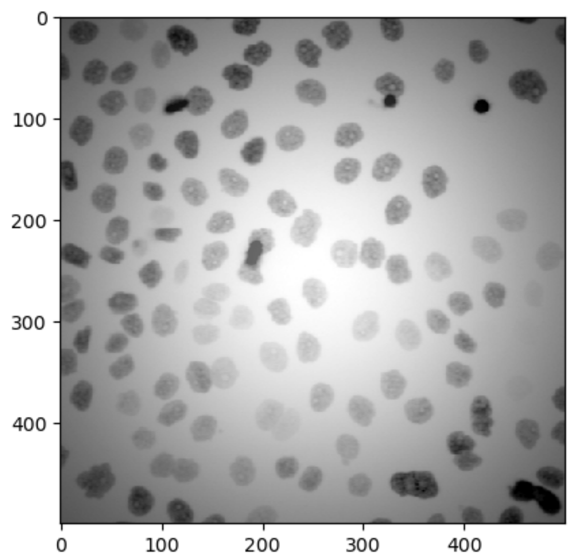

Image 4: Original image of Nuclei.png

2.2 Discussion

Images with a dark background required M=0 to first reduce the intensity of the bright areas (the stars in Stars.png), then smooth out the dark areas of the background. For an image with a bright background and darker subjects, the order of filtering had to be reversed to achieve proper background estimation.

Performing max-filtering first resulted in a good estimation of the background by eliminating the darkest pixels in the neighbourhood. The image accurately matched the gradient of the input image and did not remove much of the nuclei artifacts.

Setting the flag M=1 also made the subtraction operation add 255 to each output pixel. This was because subtracting the background from the input image caused the nuclei to have a negative intensity value, as they had lower intensities than the background. By adding 255 to each pixel, the output image displayed the nuclei clearly on a background with intensity 255.

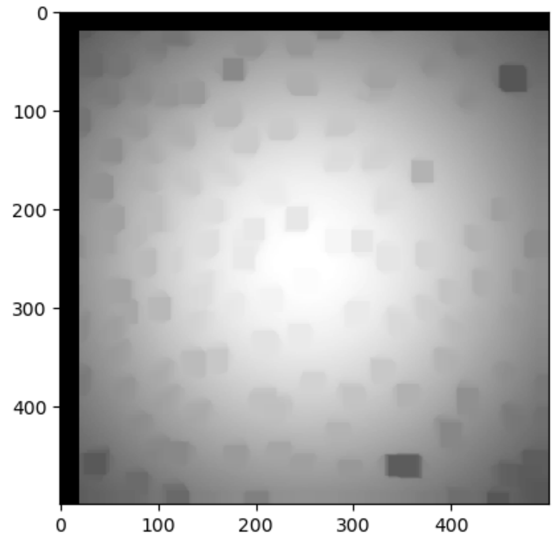

Image 5: Background extimation of Nuclei.png

The ideal value for parameter N was found to be 15. Lower values of N resulted in lower contrast between the nuclei and the background, wish is not ideal for quantitative analysis. Higher values of N provided less benefit in terms of output image quality, as well as not estimating the background as accurately because of the large neughbourhood size.

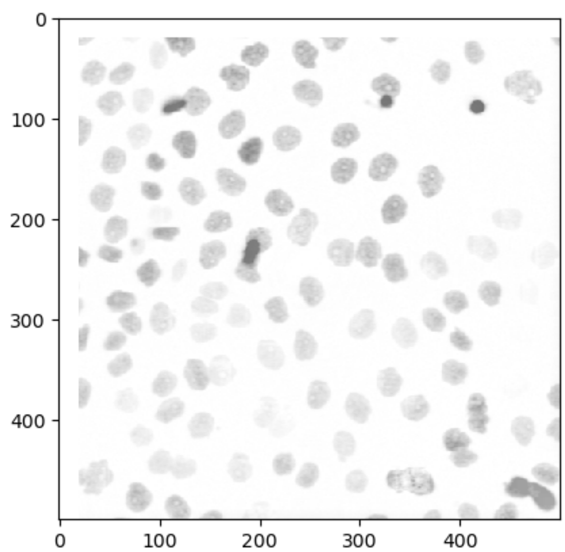

Image 6: Output image of Nuclei.png