CS663 Assignment 2 Question 2

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This document describes the findings regarding question 2 of assignment 2. For each section in the question, we have added the relevant comments and output images.

1 Overview

In this question, we have implemented the edge preserving smoothing using the bilateral filtering algorithm. In the function myBilateralFiltering.m first, we corrupt the input image using Gaussian noise whose mean is zero and standard deviation is set to 5% of the range of intensity in the input image. Then over this corrupted image(corr_image), we apply the bilateral filtering algorithm to eliminate the Gaussian noise and at the same time preserve the edges.

Finally, to compare the performance of the filtering algorithm, we calculate the root mean square difference between the input image and the filtered image. We manually tune our smoothing parameters(sig_space and sig_intensity) for getting a good filtered image.

2 Code Implementation

First, we set the standard deviation(sig) of the noise to 0.05*(difference between max and min intensity). Using this we add a Gaussian random variable to the input image(in_image). Now, we have obtained our corrupted image.

On this corrupted image, we apply the bilinear filtering. For every pixel in the input image, we use a mask with both the spatial kernel and intensity kernel. Both of the kernels use Gaussian weights. The filter mask is of some size which is chosen such that the spatial weight parameter dies down below a particular value(denoted by alpha in the code).

After the filtered image is obtained(out_image), we calculate the RMSD between the input image and the filtered image. Then the smoothing parameters are properly chosen to minimize the RMSD.

3 Results and Comments

3.1 2/data/barbara.mat Image

If we apply the above stated algorithm in the image that is provided to us in a .mat format, we get the results as shown in figure 1 below. The corresponding Gaussian mask, we have used is shown in figure 2.

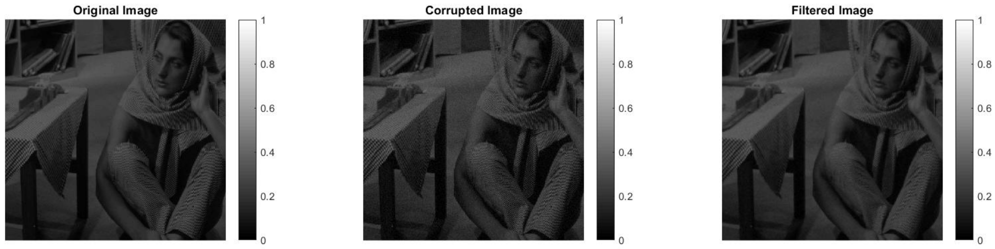

Figure 1: Results of Bilateral Filtering on 2/data/barbara.mat

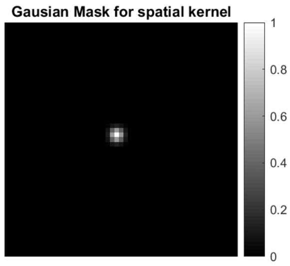

Figure 2: Gaussian filter mask for the spatial component

We can see that the Gaussian noise is reduced in the filtered image, also the edges are preserved to a good extent. The optimized parameters are $\sigma^*_{space} = 0.5$, $\sigma^*_{intensity} = 0.1$, and the corresponding $RMSD^* = 0.0148$. The below table 1 summarises the RMSD for different parameters.

RMSD for different parameters		
σ_{space}	$\sigma_{intensity}$	RMSD
$0.9{*}\sigma^*_{space}$	$\sigma^*_{intensity}$	0.0159
$1.1{*}\sigma^*_{space}$	$\sigma^*_{intensity}$	0.0142
σ^*_{space}	$0.9{*}\sigma^*_{intensity}$	0.0149
σ^*_{space}	$1.1{*}\sigma^*_{intensity}$	0.0148

Table 1: Table 1

The row 2 of the table suggests that we should have a different σ^*_{space}, but the visually the image quality gets a little distorted in that case, hence the above parameters are chosen as such.

3.2 2/data/grass.png Image

The steps mentioned in the previous section is repeated for the grass.png image and the results obtained are shown in the figure 3 below. Also the Gaussian mask is shown in figure 4.

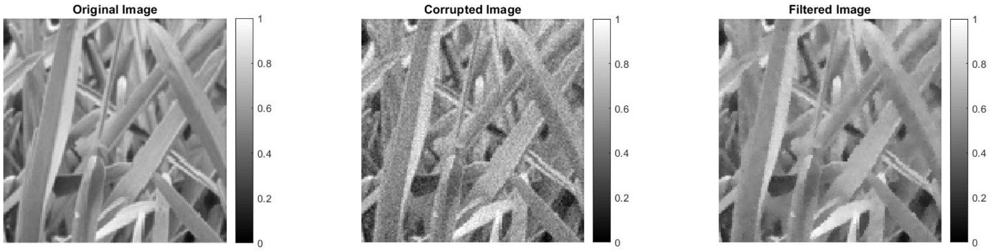

Figure 3: Results of Bilateral Filtering on 2/data/grass.png

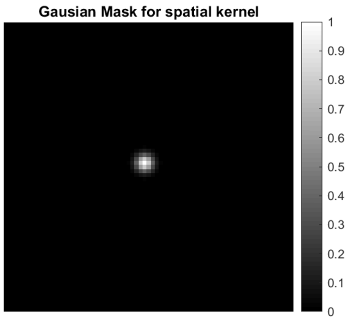

Figure 4: Gaussian filter mask for the spatial component

The result is obtained for the optimized at $\sigma^*_{space} = 1.428$, $\sigma^*_{intensity} = 0.1$, and the corresponding $RMSD^* = 0.031$. The below table 2 summarises the RMSD for different parameters.

RMSD for different parameters		
σ_{space}	$\sigma_{intensity}$	RMSD
$0.9^*\sigma^*_{space}$	$\sigma^*_{intensity}$	0.0312
$1.1^*\sigma^*_{space}$	$\sigma^*_{intensity}$	0.0320
σ^*_{space}	$0.9^*\sigma^*_{intensity}$	0.0314
σ^*_{space}	$1.1^*\sigma^*_{intensity}$	0.0314

Table 2: Table 2

Here, we see, that the RMSD increases slightly for any other parameter chosen.

3.3 2/data/honeyCombReal.png Image

The steps mentioned in the first section is repeated for the honeyCombReal.png image and the results obtained are shown in the figure 5 below. Also the Gaussian mask is shown in figure 6.

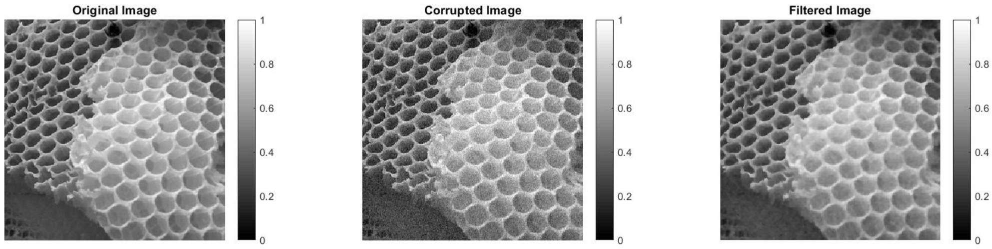

Figure 5: Results of Bilateral Filtering on 2/data/honeyCombReal.png

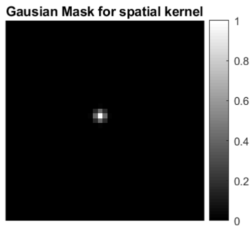

Figure 6: Gaussian filter mask for the spatial component

The result is obtained for the optimized at $\sigma^*_{space} = 0.75$, $\sigma^*_{intensity} = 0.2$, and the corresponding $RMSD^* = 0.029$. The below table 3 summarises the RMSD for different parameters.

RMSD for different parameters		
σ_{space}	$\sigma_{intensity}$	RMSD
$0.9 * \sigma^*_{space}$	$\sigma^*_{intensity}$	0.0298
$1.1 * \sigma^*_{space}$	$\sigma^*_{intensity}$	0.0289
σ^*_{space}	$0.9 * \sigma^*_{intensity}$	0.0293
σ^*_{space}	$1.1 * \sigma^*_{intensity}$	0.0290

Table 3: Table 3