CS5175 Assignment - 4 Report

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1 Introduction

This report presents a Python implementation of a Gaussian blur algorithm from scratch using numpy, math, OpenCV, and Matplotlib. The algorithm applies a Gaussian filter, demonstrating the blurring effect at different levels.

2 Gaussian Blur

Gaussian blur is a technique used to blur an image by applying a Gaussian function. The accompanying 2D Gaussian distribution illustrates a peak at the center, with the curve flattening towards the edges. If this distribution were to overlay a group of pixels in an image, it becomes evident that pixels at the center contribute more significantly to the resulting value due to the higher curve height. This mechanism essentially defines how Gaussian blur operates.

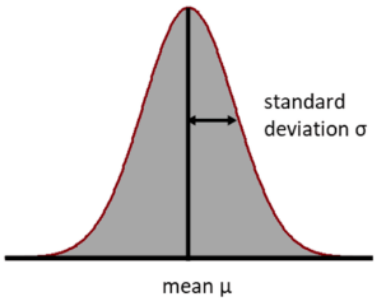

Figure 1: Gaussian Distribution

3 Implementation Details

The code incorporates space-invariant blur through the implementation of three essential functions: `make_kernel`, `pad`, and `gaussian_blur`. In particular, the `make_kernel` function is responsible for generating the blur kernel. In the context of the Gaussian blur algorithm, the kernel size is determined by the expression $6\sigma + 1$, where σ represents the standard deviation.This formula calculates the size of the square kernel used for convolution in order to achieve the desired blurring effect. .The input image undergoes padding specific to the required kernel size. Subsequently, the convolution of the kernel and the padded image is executed within the `gaussian_blur` function.

4 Results

The implementation is tested on a grayscale image ('Mandrill.png') with different sigma values: $1.6, 1.2, 1.0, 0.6, 0.3, 0.0$. If the sigma value is zero, the resulting image will be the same as the input image. The results are displayed in Figure 3.

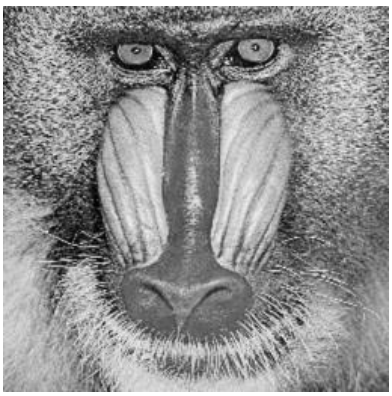

Figure 2: Original Image

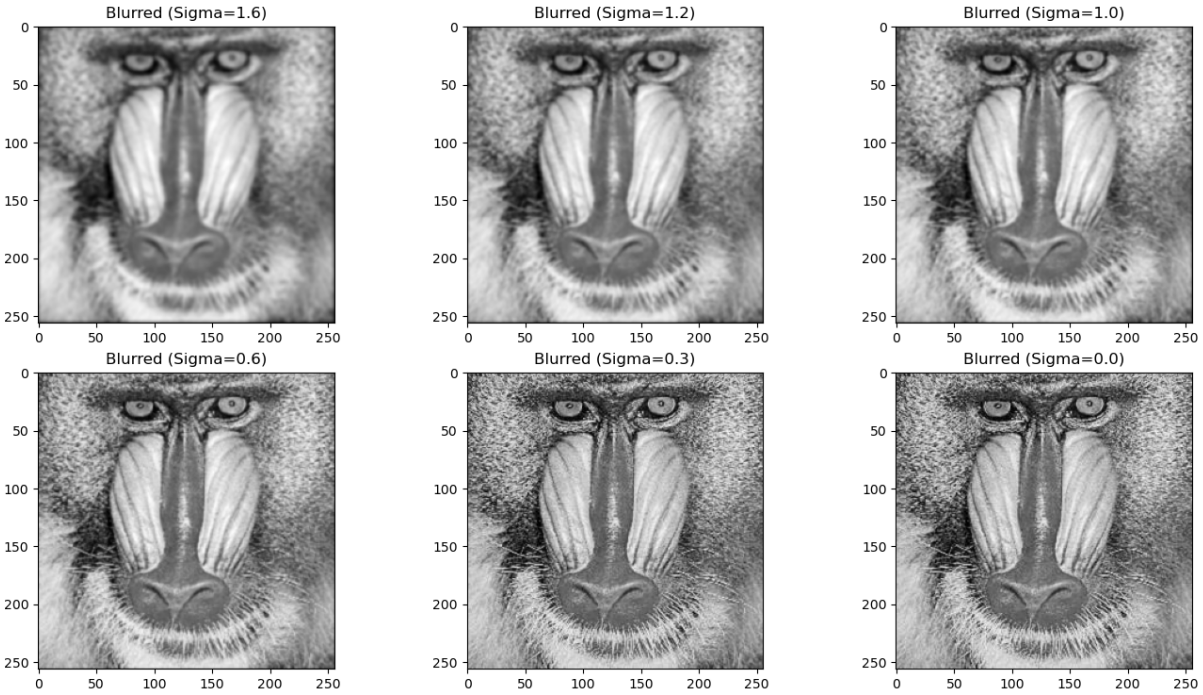

Figure 3: Original Image and Blurred Images with Different Sigma Values

5 Observations

In this assignment, we created a blur effect that changes as we adjust the sigma values. When sigma is high, the blur is strong, but when it's close to zero, the image becomes sharper. However, images with high sigma show a black border. This happens because the more blur we apply (larger sigma), the more padding is needed. This extra padding affects the border, making it darker.