Noise filter implementation

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Introduction

In the realm of image processing, mitigating noise is pivotal for extracting meaningful information and enhancing visual quality. This report presents the optimized implementation of four fundamental noise filters-Mean, Median, k-closest averaging, and threshold averaging in Python. These filters address noise challenges in diverse scenarios, offering a versatile toolkit for real-time image processing. The code focuses on speed, ensuring fast execution for real-time processing. Through concise explanations and sample outputs, this report demonstrates the effectiveness of each filter in enhancing image quality by reducing noise, providing a valuable resource for Python-based image processing applications.

Imported libraries in Python code

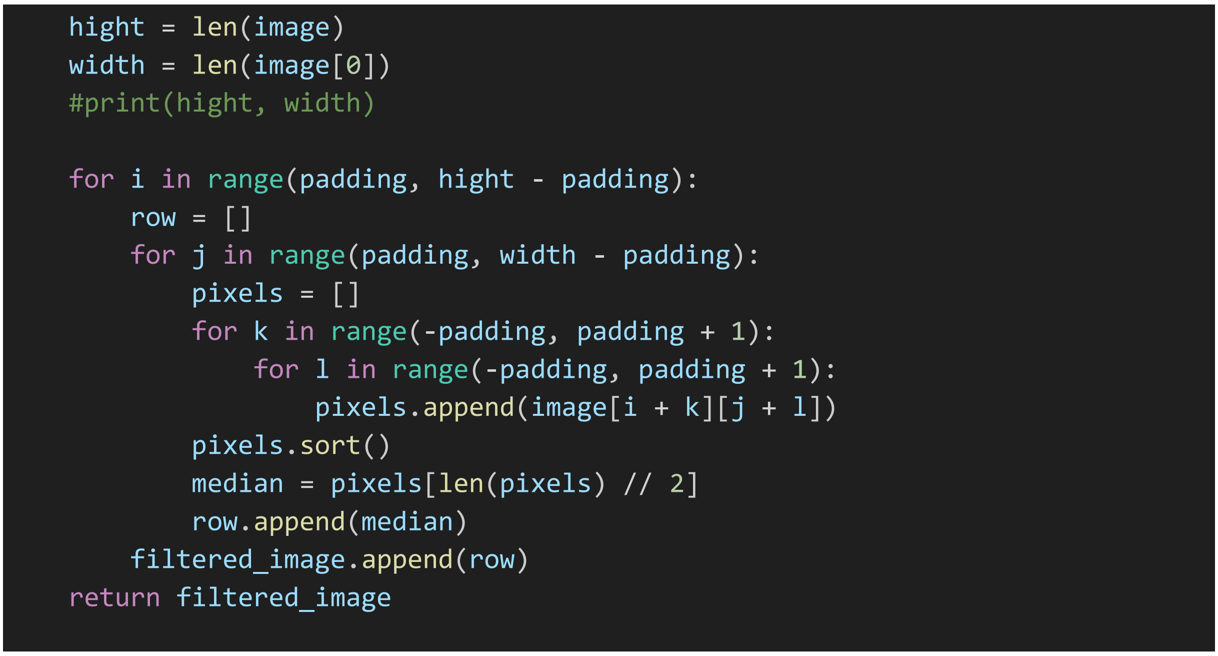
```
import numpy as np
import cv2
import matplotlib.pyplot as plt
```

Mean filter

```

def mean_filter(image, filter_size):
    filtered_image = []
    padding = filter_size // 2

    # width and height of the image
    hight = len(image)
    width = len(image[0])
    print('Image hight =', hight, 'Width =', width)

    for i in range(padding, hight - padding):
        row = []
        for j in range(padding, width - padding):
            pixels = []
            for k in range(-padding, padding + 1):
                for l in range(-padding, padding + 1):
                    pixels.append(image[i + k][j + l])
            average = sum(pixels) // (filter_size ** 2)
            row.append(average)
        filtered_image.append(row)
    return filtered_image

```

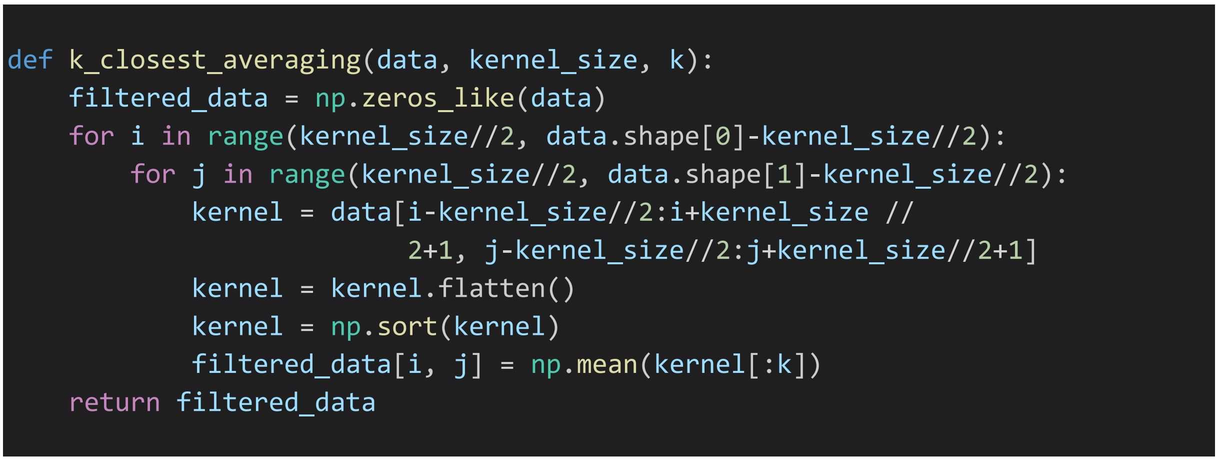
Median filter

```

def median_filter(image, filter_size):
    filtered_image = []
    padding = filter_size // 2

    # width and height of the image
```



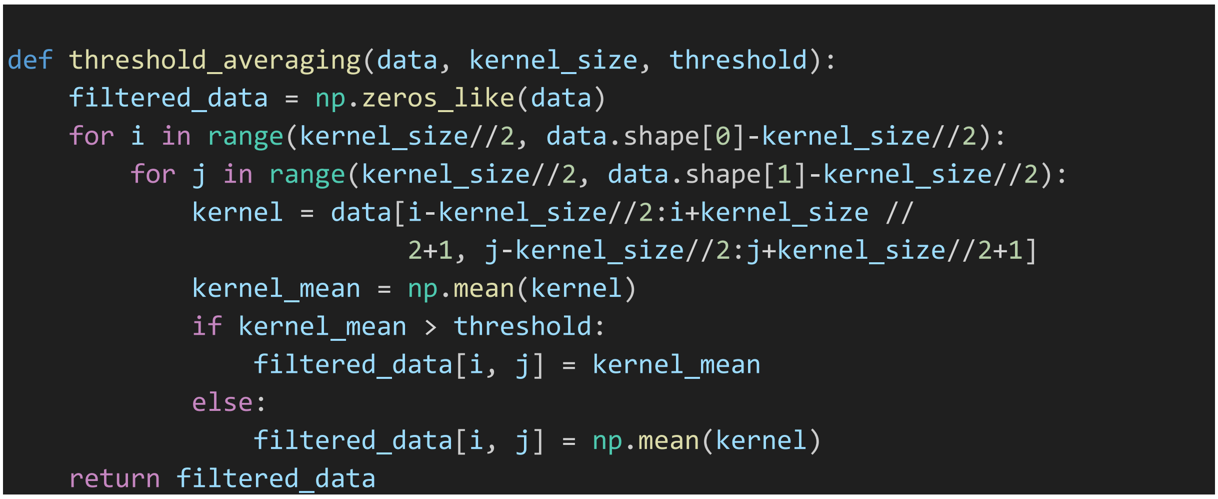
```
    hight = len(image)
    width = len(image[0])
    #print(hight, width)

    for i in range(padding, hight - padding):
        row = []
        for j in range(padding, width - padding):
            pixels = []
            for k in range(-padding, padding + 1):
                for l in range(-padding, padding + 1):
                    pixels.append(image[i + k][j + l])
            pixels.sort()
            median = pixels[len(pixels) // 2]
            row.append(median)
        filtered_image.append(row)
    return filtered_image
```

K-closest averaging filter



```
def k_closest_averaging(data, kernel_size, k):
    filtered_data = np.zeros_like(data)
    for i in range(kernel_size//2, data.shape[0]-kernel_size//2):
        for j in range(kernel_size//2, data.shape[1]-kernel_size//2):
            kernel = data[i-kernel_size//2:i+kernel_size //
                          2+1, j-kernel_size//2:j+kernel_size//2+1]
            kernel = kernel.flatten()
            kernel = np.sort(kernel)
            filtered_data[i, j] = np.mean(kernel[:k])
    return filtered_data
```

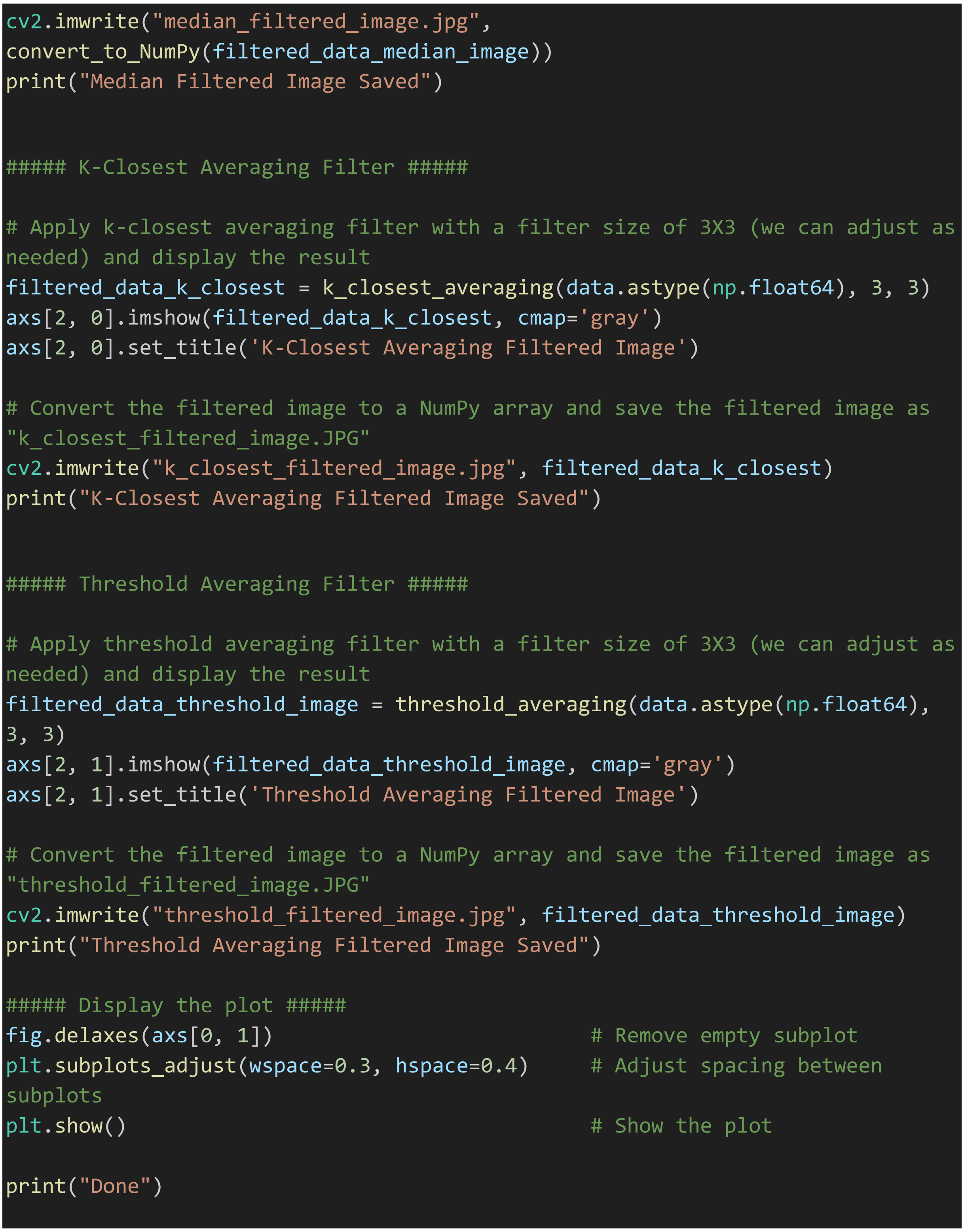
Threshold averaging filter



```
def threshold_averaging(data, kernel_size, threshold):
    filtered_data = np.zeros_like(data)
    for i in range(kernel_size//2, data.shape[0]-kernel_size//2):
        for j in range(kernel_size//2, data.shape[1]-kernel_size//2):
            kernel = data[i-kernel_size//2:i+kernel_size //
                          2+1, j-kernel_size//2:j+kernel_size//2+1]
            kernel_mean = np.mean(kernel)
            if kernel_mean > threshold:
                filtered_data[i, j] = kernel_mean
            else:
                filtered_data[i, j] = np.mean(kernel)
    return filtered_data
```

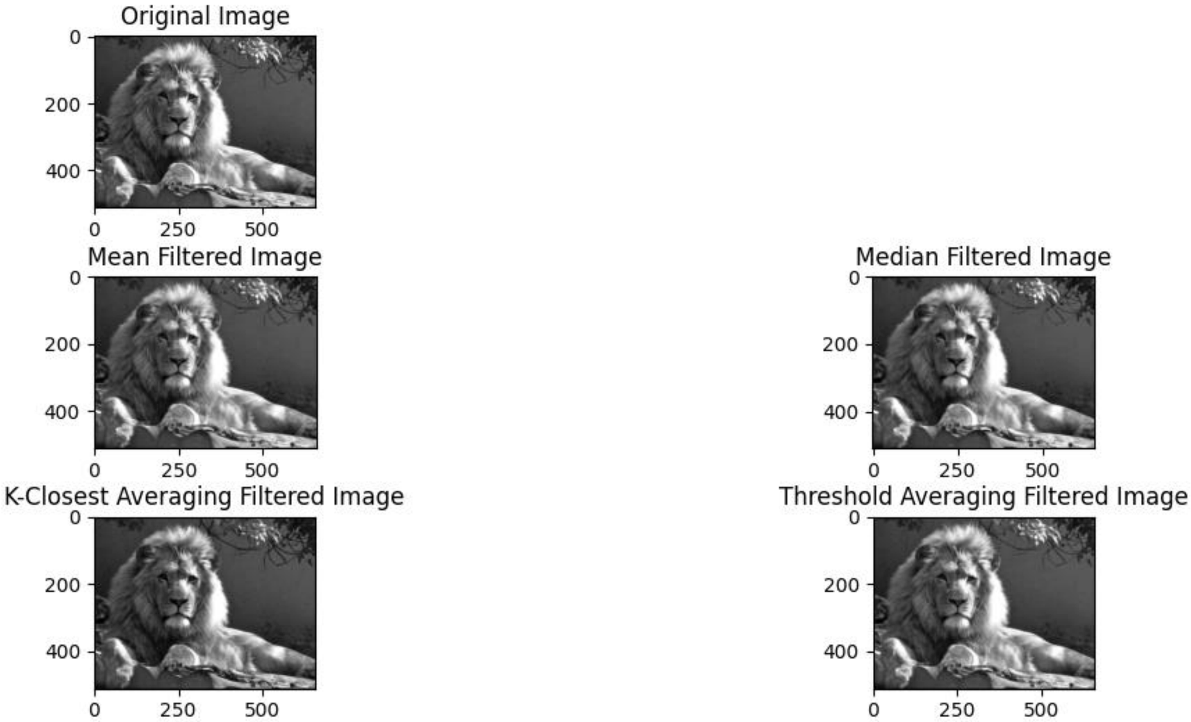
Testing with an Image

```
def convert_to_NumPy(filtered_image):
    """ Converts a list (filtered image) to a NumPy array with a data type of
unsigned 8-bit integer. """
    return np.array(filtered_image, dtype=np.uint8)


file_path = 'noiseImage.jpeg'
data = cv2.imread(file_path)
data = cv2.cvtColor(data, cv2.COLOR_BGR2GRAY)  # Convert to grayscale

# Create subplots for the original image and the filtered images
fig, axs = plt.subplots(3, 2, figsize=(10, 10))

# Show the original image
axs[0, 0].imshow(data, cmap='gray')
axs[0, 0].set_title('Original Image')


##### Mean Filter #####

# Apply mean filter with a filter size of 3 (we can adjust as needed) and
display the result
filtered_data_mean_image = mean_filter(data.astype(np.float64), 3)
axs[1, 0].imshow(filtered_data_mean_image, cmap='gray')
axs[1, 0].set_title('Mean Filtered Image')

# Convert the filtered image to a NumPy array and save the filtered image as
"mean_filtered_image.JPG"
cv2.imwrite("mean_filtered_image.jpg",
convert_to_NumPy(filtered_data_mean_image))
print("Mean Filtered Image Saved")


##### Median Filter #####

# Apply median filter with a filter size of 5 (we can adjust as needed) and
display the result
filtered_data_median_image = median_filter(data.astype(np.float64), 5)
axs[1, 1].imshow(filtered_data_median_image, cmap='gray')
axs[1, 1].set_title('Median Filtered Image')

# Convert the filtered image to a NumPy array and save the filtered image as
"median_filtered_image.JPG"
```



```
cv2.imwrite("median_filtered_image.jpg",
convert_to_NumPy(filtered_data_median_image))
print("Median Filtered Image Saved")


##### K-Closest Averaging Filter #####

# Apply k-closest averaging filter with a filter size of 3X3 (we can adjust as
needed) and display the result
filtered_data_k_closest = k_closest_averaging(data.astype(np.float64), 3, 3)
axs[2, 0].imshow(filtered_data_k_closest, cmap='gray')
axs[2, 0].set_title('K-Closest Averaging Filtered Image')

# Convert the filtered image to a NumPy array and save the filtered image as
"k_closest_filtered_image.JPG"
cv2.imwrite("k_closest_filtered_image.jpg", filtered_data_k_closest)
print("K-Closest Averaging Filtered Image Saved")


##### Threshold Averaging Filter #####

# Apply threshold averaging filter with a filter size of 3X3 (we can adjust as
needed) and display the result
filtered_data_threshold_image = threshold_averaging(data.astype(np.float64),
3, 3)
axs[2, 1].imshow(filtered_data_threshold_image, cmap='gray')
axs[2, 1].set_title('Threshold Averaging Filtered Image')

# Convert the filtered image to a NumPy array and save the filtered image as
"threshold_filtered_image.JPG"
cv2.imwrite("threshold_filtered_image.jpg", filtered_data_threshold_image)
print("Threshold Averaging Filtered Image Saved")

##### Display the plot #####
fig.delaxes(axs[0, 1])                           # Remove empty subplot
plt.subplots_adjust(wspace=0.3, hspace=0.4)      # Adjust spacing between
subplots
plt.show()                                       # Show the plot

print("Done")
```

Results


Original Image
Mean Filtered Image
Median Filtered Image
K-Closest Averaging Filtered Image
Threshold Averaging Filtered Image
0
200
400
0
250
500

GitHub Link

https://github.com/ThejanB/ImagePrecessing