E/20/100
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```
import numpy as np
import cv2
from scipy.ndimage import gaussian_filter, median_filter

# Load a noisy image
image = cv2.imread("/content/Sample image.jpg", cv2.IMREAD_GRAYSCALE)

# Manual mean filtering
def mean_filter(image, mask_size):
    padded_image = np.pad(image, mask_size // 2, mode='reflect')
    filtered_image = np.zeros_like(image, dtype=np.float32)

    for i in range(image.shape[0]):
        for j in range(image.shape[1]):
            region = padded_image[i:i + mask_size, j:j + mask_size]
            filtered_image[i, j] = np.mean(region)

    return filtered_image.astype(np.uint8)

# Manual highpass filter (edge detection)
def highpass_filter(image, mask_size):
    mean_filtered = mean_filter(image, mask_size)
    highpass = image.astype(np.float32) - mean_filtered
    return np.clip(highpass, 0, 255).astype(np.uint8)

# Manual lowpass filter
def lowpass_filter(image, mask_size):
    return mean_filter(image, mask_size)

# Bilateral filter (manual approximation)
def bilateral_filter(image, mask_size, sigma_d, sigma_r):
    padded_image = np.pad(image, mask_size // 2, mode='reflect')
    filtered_image = np.zeros_like(image, dtype=np.float32)

    for i in range(image.shape[0]):
        for j in range(image.shape[1]):
            region = padded_image[i:i + mask_size, j:j + mask_size]
            center_value = image[i, j]

            spatial_weight = np.exp(-((np.arange(mask_size) -
mask_size // 2)[:, None] ** 2 +
                                      (np.arange(mask_size) -
mask_size // 2)[None, :] ** 2) / (2 * sigma_d ** 2))
            intensity_weight = np.exp(-(region - center_value) ** 2 /
(2 * sigma_r ** 2))

            weight = spatial_weight * intensity_weight
            filtered_image[i, j] = np.sum(region * weight) /
np.sum(weight)
```

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    return filtered_image.astype(np.uint8)

# Gaussian filter
def gaussian_filter_manual(image, mask_size, sigma):
    padded_image = np.pad(image, mask_size // 2, mode='reflect')
    filtered_image = np.zeros_like(image, dtype=np.float32)

    kernel = np.exp(-((np.arange(mask_size) - mask_size // 2)[:, None]
** 2 +
                      (np.arange(mask_size) - mask_size // 2)[None, :]
** 2) / (2 * sigma ** 2))
    kernel /= np.sum(kernel)

    for i in range(image.shape[0]):
        for j in range(image.shape[1]):
            region = padded_image[i:i + mask_size, j:j + mask_size]
            filtered_image[i, j] = np.sum(region * kernel)

    return filtered_image.astype(np.uint8)

# Laplacian filter
def laplacian_filter(image, mask_size, sigma):
    gaussian = gaussian_filter_manual(image, mask_size, sigma)
    laplacian = image - gaussian
    return np.clip(laplacian, 0, 255).astype(np.uint8)

# Median filter
def median_filter_manual(image, mask_size):
    padded_image = np.pad(image, mask_size // 2, mode='reflect')
    filtered_image = np.zeros_like(image, dtype=np.uint8)

    for i in range(image.shape[0]):
        for j in range(image.shape[1]):
            region = padded_image[i:i + mask_size, j:j + mask_size]
            filtered_image[i, j] = np.median(region)

    return filtered_image

# Applying filters
mean_filtered_3x3 = mean_filter(image, 3)
mean_filtered_5x5 = mean_filter(image, 5)
highpass_filtered_3x3 = highpass_filter(image, 3)
highpass_filtered_5x5 = highpass_filter(image, 5)
lowpass_filtered_3x3 = lowpass_filter(image, 3)
lowpass_filtered_5x5 = lowpass_filter(image, 5)
bilateral_filtered = bilateral_filter(image, 5, sigma_d=2, sigma_r=30)
gaussian_filtered = gaussian_filter_manual(image, 5, sigma=1)
laplacian_filtered = laplacian_filter(image, 5, sigma=1)
median_filtered = median_filter_manual(image, 5)
```

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import matplotlib.pyplot as plt

# Titles for the filters
titles = [
    "Original",
    "Mean Filter 3x3",
    "Mean Filter 5x5",
    "Highpass Filter 3x3",
    "Highpass Filter 5x5",
    "Lowpass Filter 3x3",
    "Lowpass Filter 5x5",
    "Bilateral Filter",
    "Gaussian Filter",
    "Laplacian Filter",
    "Median Filter"
]

# Corresponding images
images = [
    image,
    mean_filtered_3x3,
    mean_filtered_5x5,
    highpass_filtered_3x3,
    highpass_filtered_5x5,
    lowpass_filtered_3x3,
    lowpass_filtered_5x5,
    bilateral_filtered,
    gaussian_filtered,
    laplacian_filtered,
    median_filtered
]

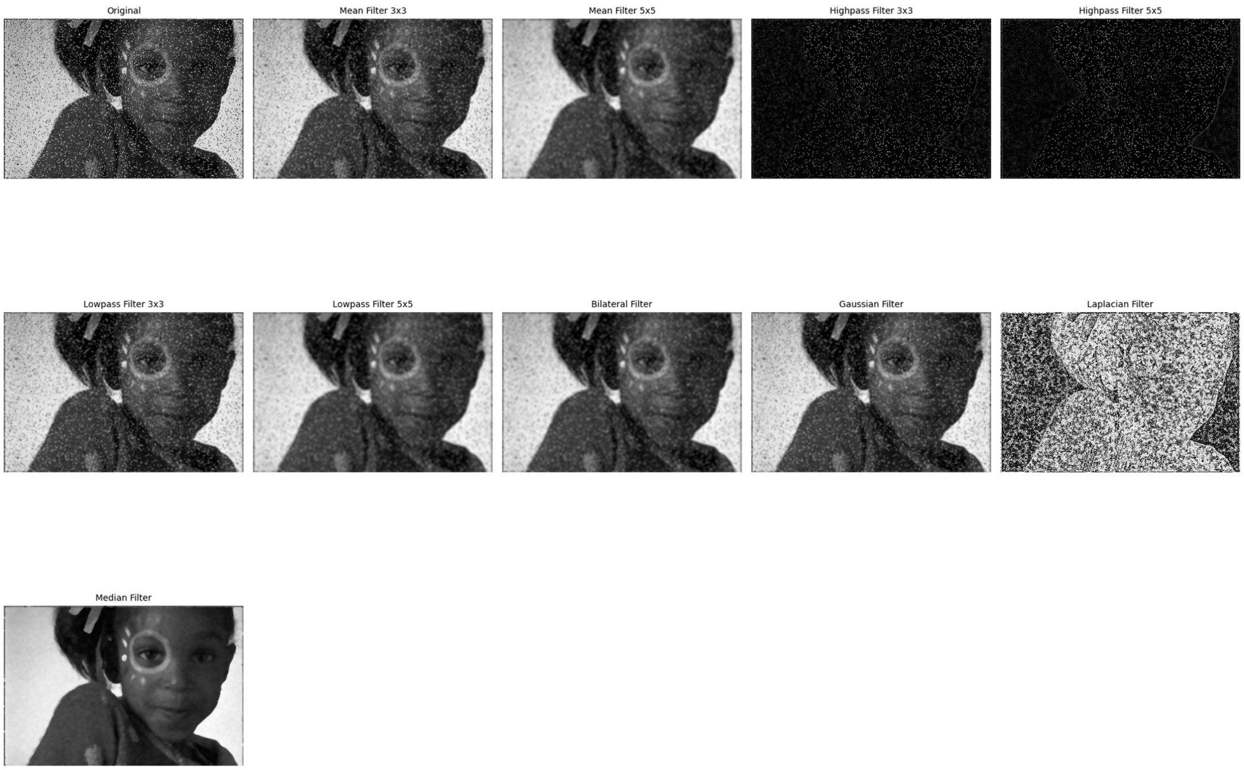
# Set the number of images per row
images_per_row = 5
rows = len(images) // images_per_row + (len(images) % images_per_row != 0)

# Adjust figure size for larger images
plt.figure(figsize=(20, 5 * rows))

# Plot each image
for i in range(len(images)):
    plt.subplot(rows, images_per_row, i + 1)
    plt.imshow(images[i], cmap='gray')  # Grayscale images, no need for color conversion
    plt.title(titles[i], fontsize=10)
    plt.axis('off')

plt.tight_layout()
plt.show()
```

```
cv2.waitKey(0)
cv2.destroyAllWindows()
```




```
import matplotlib.pyplot as plt

# Function to compute and display histograms
def plot_histogram(image, title):
    plt.hist(image.ravel(), bins=256, range=[0, 256], color='black',
alpha=0.7)
    plt.title(title)
    plt.xlabel("Pixel Intensity")
    plt.ylabel("Frequency")
    plt.grid(False)

# Display images and histograms for comparison
filters = [
    ("Original", image),
    ("Mean Filter 3x3", mean_filtered_3x3),
    ("Mean Filter 5x5", mean_filtered_5x5),
    ("Highpass Filter 3x3", highpass_filtered_3x3),
    ("Highpass Filter 5x5", highpass_filtered_5x5),
    ("Lowpass Filter 3x3", lowpass_filtered_3x3),
    ("Lowpass Filter 5x5", lowpass_filtered_5x5),
```

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    ("Bilateral Filter", bilateral_filtered),
    ("Gaussian Filter", gaussian_filtered),
    ("Laplacian Filter", laplacian_filtered),
    ("Median Filter", median_filtered)
]

plt.figure(figsize=(20, len(filters) * 4))

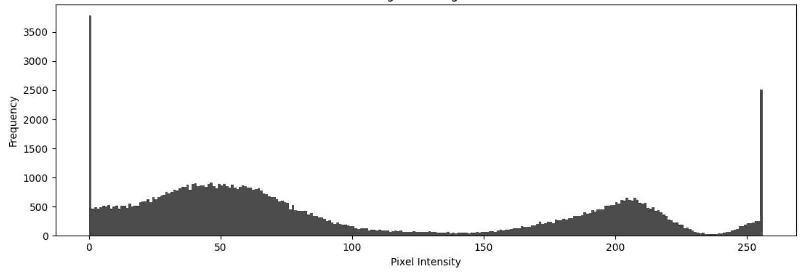
# Loop through the images and their titles
for i, (title, img) in enumerate(filters):
    # Show the image
    plt.subplot(len(filters), 2, 2 * i + 1)
    plt.imshow(img, cmap="gray")
    plt.title(f"{title} Image")
    plt.axis('off')

    # Show the histogram
    plt.subplot(len(filters), 2, 2 * i + 2)
    plot_histogram(img, f"{title} Histogram")

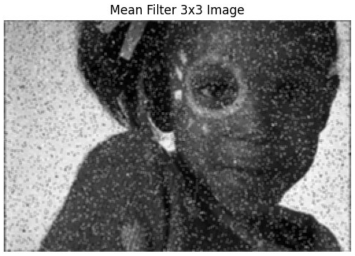
plt.tight_layout()
plt.show()
```

Original Image

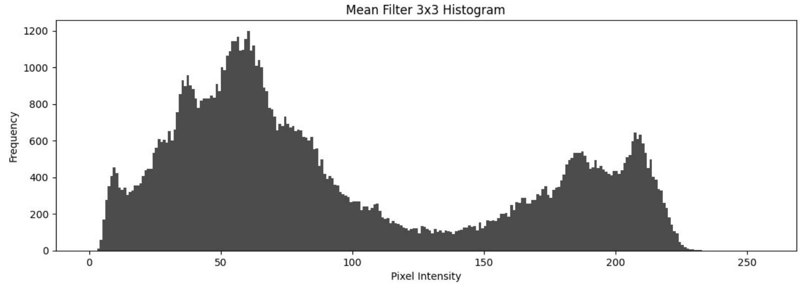
Original Histogram



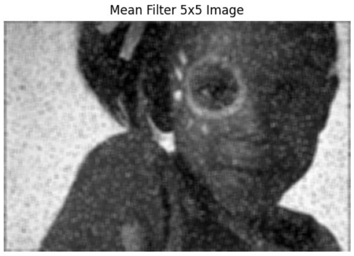
Mean Filter 3x3 Image



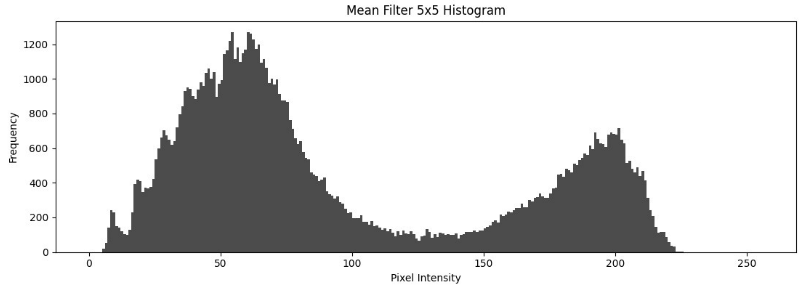
Mean Filter 3x3 Histogram



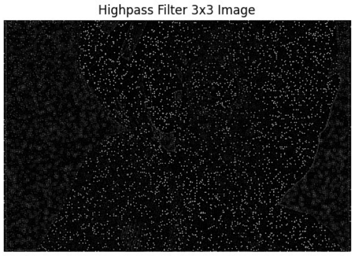
Mean Filter 5x5 Image



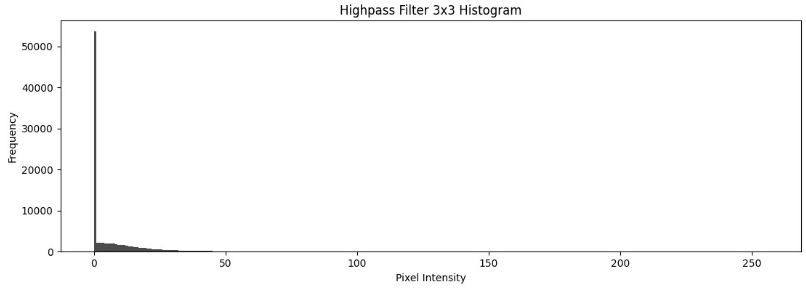
Mean Filter 5x5 Histogram



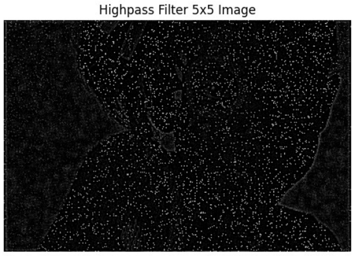
Highpass Filter 3x3 Image



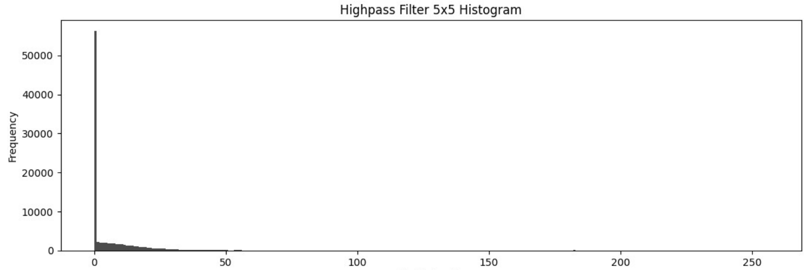
Highpass Filter 3x3 Histogram



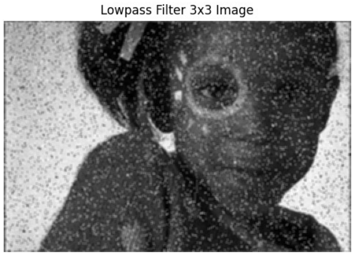
Highpass Filter 5x5 Image



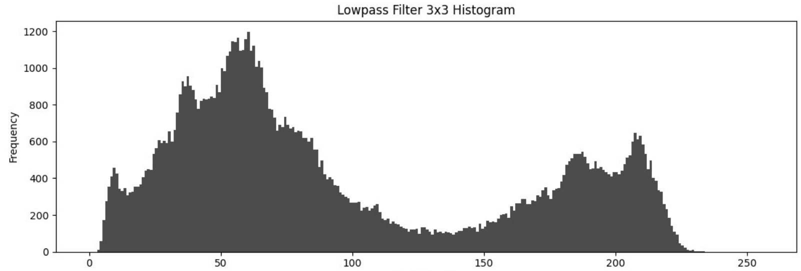
Highpass Filter 5x5 Histogram



Lowpass Filter 3x3 Image



Lowpass Filter 3x3 Histogram



##**Observations Comparing Original Image and Filtered Images:**

Mean Filtering:

- The mean filter smoothens the image, reducing noise by averaging neighboring pixel values.
- Fine details are blurred, and edges appear softer.

Highpass Filtering:

- Highpass filters emphasize edges by subtracting low-frequency components from the image.
- The resulting images highlight contours and details but may appear noisier.

Lowpass Filtering:

- These filters suppress high-frequency noise, leading to smoother images but also blurring details. Bilateral Filtering:
- It smoothens the image while preserving edges, making it effective for reducing noise without losing details.

Gaussian Filtering:

- Produces a more natural smoothing effect than the mean filter due to the Gaussian weighting of pixel intensities.

Laplacian Filtering:

- Enhances edges and transitions but amplifies noise in smoother regions. Median Filtering:
- Effectively removes salt-and-pepper noise while retaining edge details.

##**Comparing Histograms:**

Original Histogram:

- The original image's histogram typically spans a wide range of intensities, reflecting natural variations. Filtered Histograms:

Filtered image histogram:

- Peaks in the histogram are less sharp, reflecting reduced intensity variations due to smoothing. Highpass and Laplacian Filters:
- The histogram shows more high-frequency components, emphasizing edges and transitions. Median Filter:
- Removes outliers (e.g., noise spikes) in the histogram while preserving the overall shape. Bilateral Filter:
- Similar to the median filter but retains intensity transitions, creating a hybrid histogram with fewer noise-induced variations.