Assignment 2: CS 663, Fall 2024

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1. **Implement local histogram equalization of sizes 7 × 7, 31 × 31, 51 × 51, 71 × 71 on the images 'LC1.png' and 'LC2.jpg' from the homework folder. Comment on your results in your report and compare it to global histogram equalization, which you can use from the image processing toolbox of MATLAB. Point out regions where the local method produces better local contrast than the global histogram equalization. [15 points]**

Soln:

```
% PseudoCode of Local Histogram Equalization.
% Full Code for Global and Local Historgram Equalization submitted in the "code" directory
Function localHistogramEqualization(input_image):
    1. Define the window size for local neighborhood processing
    2. Compute half_window
    3. Pad the input_image symmetrically with half_window on all sides.
    4. Initialize an output_image
    5. Loop through each pixel (i, j) in input_image:
        a. Extract the window_size x window_size neighborhood centered at pixel (i, j)
        b. Initialize an array hist_counts of size 256 (to store histogram of intensities).
        c. Loop through each pixel in the neighborhood:
            i. Get the pixel intensity value.
            ii. Increment the corresponding bin in hist_counts based on the pixel intensity.
        d. Compute the CDF from the histogram.
        e. Get the original intensity of pixel (i, j) from input_image.
        f. Map the original intensity to a new intensity using the CDF.
        g. Assign the new intensity to pixel (i, j) in output_image.
    6. Convert output_image to an appropriate format, Save and Display
End Function
```

Local histogram equalization is more useful when enhancing details in specific regions of an image, especially when the image has varying lighting conditions or when you want to improve contrast in areas with low local contrast. It finds uses when different areas need to be independently enhanced, like medical imaging or night-time photography.

Global histogram equalization is better when improving overall contrast of an image with uniform lighting. It works well when the the intensity histogram is compressed in a small region, and you want to stretch the contrast across the entire histogram. It's computationally more efficient and suitable for insignificant local contrast variations.

Smaller Window Size in case of Local Histogram Equalization, accounts for finer details, and consequently more noise and imaginary artifacts. The final output gets more closer to the original image in terms of its intensity distribution as the window size decreases and ultimately becomes 1 pixel. Moreover, a smaller window size is computationally more expensive.

Larger Window Size in case of Local Histogram Equalization, takes things more into the global perspective, reducing the risk of any additional noise or artifacts. It provides smoother transitions and maintains a more natural appearance, but might fail to focus on finer details. The final output gets more closer to the output of Global Histogram Equalization in terms of its intensity distribution as the window size increases and ultimately becomes the full image. A larger window size requrires lesser computing power.

Thus it is important to have an optimal filter size, considering all tradeoffs and variances.

Figure 1: Original Image (LC2)

Figure 2: Local Histogram Equalization, Window 7

Figure 3: Local Histogram Equalization, Window 31

Figure 4: Global Histogram Equalization

Figure 5: Local Histogram Equalization, Window 51

Figure 6: Local Histogram Equalization, Window 71

Figure 7: Comparison of Histogram Equalization Techniques

Figure 8: Original Image (LC1)

Figure 9: Local Histogram Equalization, Window 7

Figure 10: Local Histogram Equalization, Window 31

Figure 11: Global Histogram Equalization

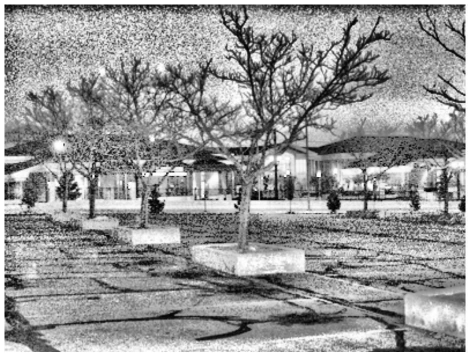

Figure 12: Local Histogram Equalization, Window 51

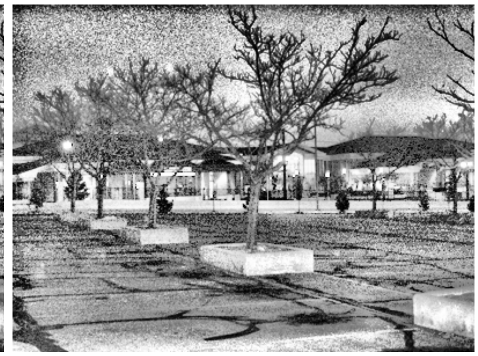

Figure 13: Local Histogram Equalization, Window 71

Figure 14: Comparison of Histogram Equalization Techniques