

## Exercise-9



Figure 1: The original LC1 (*left*) and LC2 (*right*) images given to us in the problem statement. We observe that LC1 contains a huge number of dark pixels and very few bright pixels. On the other hand, LC2 contains a huge number of intermediate-valued pixels and very low number of bright and dark pixels. Hence, clearly the salient features in the two images are washed out due to skewed density functions of these images.

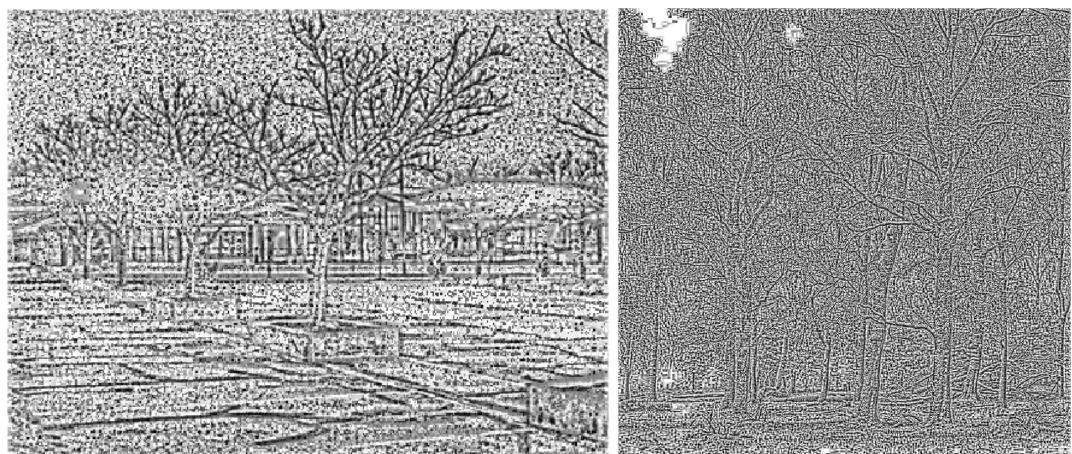


Figure 2: Local histogram equalization of size  $7 \times 7$  implemented on LC1 (*left*) and LC2 (*right*) images. We observe that some boundaries of trees and tiles on the floor of image LC1 have been marked out and enhanced. However, in addition to these benefits, we also observe that the noise in the image is also very enhanced due to very small size of the equalizer. A similar effect is also observed in the image LC2, where the leaves and trees edges have been nicely identified, but are overshadowed by the highly enhanced noise in the image, which is undesirable in general.



Figure 3: Local histogram equalization of size  $31 \times 31$  implemented on LC1 (left) and LC2 (right) images. As is clearly evident from the images, the results are far more better when using an equalizer of size  $31 \times 31$ , as compared to a smaller equalizer of size  $7 \times 7$ . In the image LC1, we can now clearly spot the building in the background, the little bushes, tiles on the floor, leaves, stems and pots of the trees. However, the enhanced noise in the sky region and on the floor still persist. In the image LC2, we can now much more clearly locate the positions of the stems, branches and leaves of all the trees, as compared to the original foggy washed out image and the noisy image enhanced with a smaller equalizer. However, the excessive noise near the ground still remains a concern. Also, a small sky patch visible through the woods towards top-left is consistently bad, despite of larger equalizer being used.



Figure 4: Local histogram equalization of size  $51 \times 51$  implemented on LC1 (left) and LC2 (right) images. The use of larger equalizer has enhanced the contrast even further. For example, in image LC1, a straightforward comparison of  $31 \times 31$  sized and  $51 \times 51$  sized equalizer when applied to the image reveals that the contrast between the sky and tree leaves and branches; floor and pots of the trees; and building roof tops and sky is now enhanced. Also, the noise on the ground tiles and sky is now relatively suppressed. In image LC2, again the contrast between the tree leaves and sky background; branches of trees and sky; stem of trees and sky is now enhanced. The sky patch on the top-left corner however continues to be deteriorated. The noise on the ground has also relatively improved.



Figure 5: Local histogram equalization of size  $71 \times 71$  implemented on LC1 (left) and LC2 (right) images. The noise in the sky and floor pixels has significantly improved. However, the use of bigger equalizer has significantly compromised the contrast between the trees and sky; buildings and sky; and the tree pots and floor tiles. Similar observations can be made in the image LC2 too: loss of contrast which was gained with the use of  $51 \times 51$  equalizer along with improvement in noise near the ground. However, the sky-patch on the top-right is consistently affected.



Figure 6: Global histogram equalization implemented on LC1 (left) and LC2 (right) images. The usage of global histogram equalization has suppressed the noise in the sky pixels and the ground tiles pixels significantly in image LC1. Even in the image LC2, the usage of global equalization has suppressed the noise near the ground which was clearly evident in the local histogram equalized images. Also, the top-left corner in the GHE image is no more affected, as was the case with LHE images. However, as is clearly evident, this extensive noise suppression came at the cost of contrast in the image, which is clearly poor as compared to the LHE images. For example, in the GHE image of LC1, it is very hard to distinguish between the branches of the trees and the roof tops. Also, the contrast between the pots of the plants and floor is now relatively compromised. In the GHE LC2 image, we can clearly distinguish between the trees in front and the trees in the background. This was not very clear in the LHE images. However, the contrast between the leaves/bunch of leaves is now compromised.