Assignment 03 - Report

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Objective

Problem 1.

Decompose the Building image (Fig.1) into 8-bit planes. Show the bit planes. Then reconstruct the image back by removing the three least significant bit planes. What will happen if you reconstruct the image by removing the three most significant bit planes?

Problem 2.

Write a program that will transform a given image (Fig.2(a)) in such a way that the resultant image histogram is equivalent to the histogram of another image (Fig.2 (b)). In the process, show the individual histograms and the intensity transformation curve.

Problem 3.

Perform gamma transformation and histogram equalization (separately) on the given hazy image (Fig. 3 (a)) to enhance the contrast of the image. Choose the parameter (if any) of these transformations such that the resultant images have dehazing effects. Fuse both the images to generate a single image such that it has a better visual appearance. Note that the objective is to get a better-dehazed result. Now, consider the haze model

$$I(x) = J(x)t(x) + A(1 - t(x)),$$

where $I(x)$ is the given hazy image. $J(x)$ can be approximated with the resultant image that has been generated by fusing the results of gamma transformation and histogram equalization. Assume the atmospheric light is $A = [0.8159, 0.8186, 0.8272]$. Now estimate the transmission map $t(x)$ using the above equation. To see the accuracy of the results, compute the Euclidean distance between the estimated transmission map and the given transmission map (Fig.3(b)). A lower distance indicates a better dehazing result.

Problem 4.

Find out the difference between averaging operation and weighted averaging (higher weight to centre pixel) operation in Fig. 4 by applying spatial filtering. For this purpose, convolve the image with 9 × 9 masks (averaging mask and weighted averaging mask).

Methods and Experiments

Problem 1:

Decompose the Building image (Fig.1) into 8-bit planes. Show the bit planes. Then reconstruct the image back by removing the three least significant bit planes. What will happen if you reconstruct the image by removing the three most significant bit planes?

Methods used:

We first read the image in grayscale and then appended all the pixel values in a list as a string. Using the same list, we are calculating the bit planes by extracting the pixel values from the list. Image (Fig.1) is broken down into 8 different bit planes.
Further, these bit planes are concatenated after removing 3 least significant bit planes.
Similarly, they are again concatenated after removing 3 highest significant bit planes.
Results are shown in the observation section.

Problem 2:

Write a program that will transform a given image (Fig.2(a)) in such a way that the resultant image histogram is equivalent to the histogram of another image (Fig.2 (b)). In the process, show the individual histograms and the intensity transformation curve.

Methods Used:

The histogram equalization technique is used in this question. We first inserted both the images *(Fig.2(a)) and (Fig.2 (b)). Histograms of both the images are printed first of all then histogram specification is performed on the (Fig.2(a)) after that and the histogram of the final image is shown. All the outputs are shown in the observation section.*

Problem 3:

Perform gamma transformation and histogram equalization (separately) on the given hazy image (Fig. 3 (a)) to enhance the contrast of the image. Choose the parameter (if any) of these transformations such that the resultant images have dehazing effects. Fuse both the images to generate a single image such that it has a better visual appearance. Note that the objective is to get a better-dehazed result. Now, consider the haze model

$$I(x) = J(x)t(x) + A(1 - t(x)),$$

where $I(x)$ is the given hazy image. $J(x)$ can be approximated with the resultant image that has been generated by fusing the results of gamma transformation and histogram equalization. Assume the atmospheric light is $A = [0.8159, 0.8186, 0.8272]$. Now estimate the transmission map $t(x)$ using the above equation. To see the accuracy of the results, compute the Euclidean distance between the estimated transmission map and the given transmission map (Fig.3(b)). A lower distance indicates a better dehazing result.

Methods Used:

We have first calculated the gamma transformation of the original image and then performed the histogram equalization to enhance the contrast of the image. We calculated the PDF for all channels using total pixels and then we constructed a new image by converting these PDF into CDF. These CDF of each channel are stored in the resultant image.

As per the given equation, we calculated the transformation map for each value of A and calculated the euclidian distance between the obtained transformation map and the given transformation map.

Problem 4:

Find out the difference between averaging operation and weighted averaging (higher weight to centre pixel) operation in Fig. 4 by applying spatial filtering. For this purpose, convolve the image with 9 × 9 masks (averaging mask and weighted averaging mask).

Methods Used:

We first imported the lena_face.jpeg image and then we added the padding to the original image. The padded image is passed to the convolution function which returns the resultant image after convolution. The original image after padding and the resultant image after convolution is shown in the observation section.

- *Size of the original image - (579,663)*
- *Size of the image after padding - (587,671)*
- *Size of the image after convolution using 9x9 kernel - (579,663)*

Observations

Problem 1:

Decompose the Building image (Fig.1) into 8-bit planes. Show the bit planes. Then reconstruct the image back by removing the three least significant bit planes. What will happen if you reconstruct the image by removing the three most significant bit planes?

Observations:

Figure: All 8-bit planes of the given image

Figure: Image reconstruction after removing three least significant bit planes

Figure: Image reconstruction after removing three most significant bit planes

Problem 2:

Write a program that will transform a given image (Fig.2(a)) in such a way that the resultant image histogram is equivalent to the histogram of another image (Fig.2 (b)). In the process, show the individual histograms and the intensity transformation curve.

Observations:

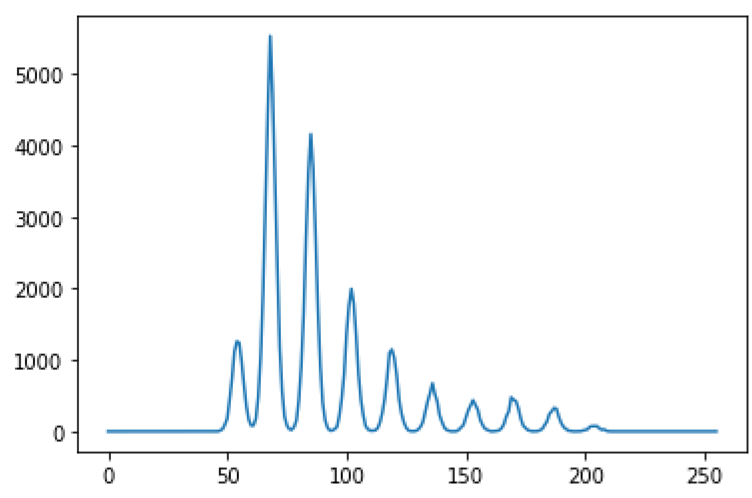

Figure: Histogram of Einstein image

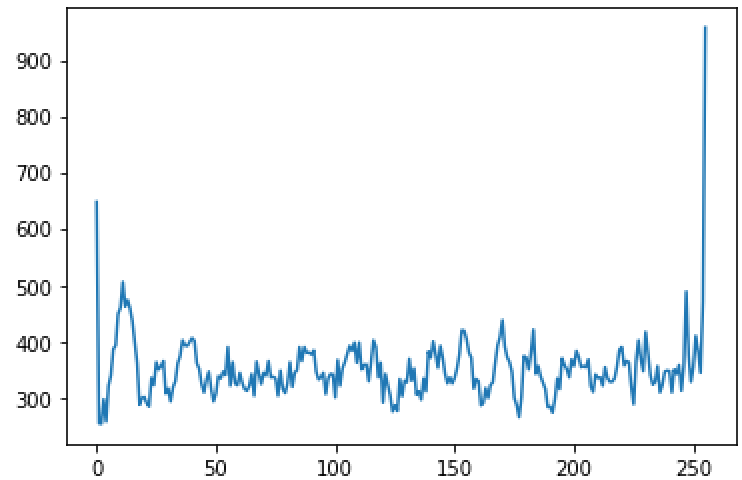

Figure: Histogram of Lena's image

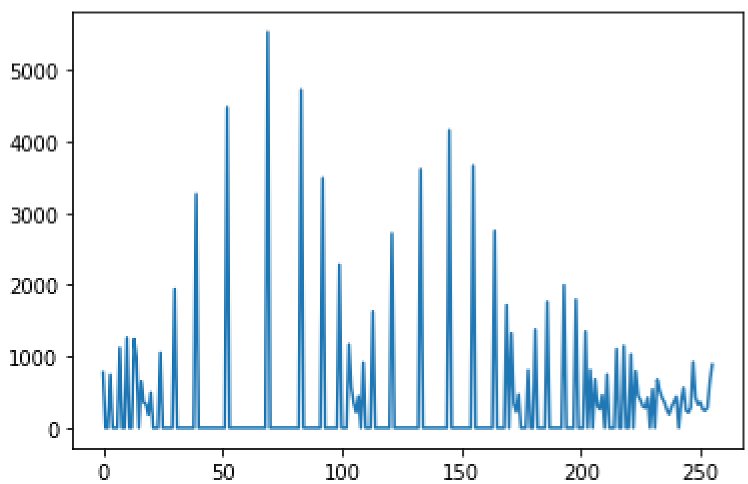

Figure: Histogram of the resultant image after histogram specification

Problem 3:

Perform gamma transformation and histogram equalization (separately) on the given hazy image (Fig. 3 (a)) to enhance the contrast of the image. Choose the parameter (if any) of these transformations such that the resultant images have dehazing effects. Fuse both the images to generate a single image such that it has a better visual appearance. Note that the objective is to get a better-dehazed result. Now, consider the haze model

$$I(x) = J(x)t(x) + A(1 - t(x)),$$

where $I(x)$ is the given hazy image. $J(x)$ can be approximated with the resultant image that has been generated by fusing the results of gamma transformation and histogram equalization. Assume the atmospheric light is A = [0.8159, 0.8186, 0.8272]. Now estimate the transmission map $t(x)$ using the above equation. To see the accuracy of the *results, compute the Euclidean distance between the estimated transmission map and the given transmission map (Fig.3(b)). A lower distance indicates a better dehazing result.*

Observations:

Figure: Contrast-enhanced image after gamma transformation

Figure: Calculated Transformation Map

Problem 4:

Find out the difference between averaging operation and weighted averaging (higher weight to centre pixel) operation in Fig. 4 by applying spatial filtering. For this purpose, convolve the image with 9 × 9 masks (averaging mask and weighted averaging mask).

Observations:

Figure: Image after adding padding

Figure: Image after performing the simple averaging on padded image

Figure: Image after performing the weighted averaging operation on padded image

Conclusion

Problem-1:
Takeaways - We found that we can reconstruct the image comparable to the original image when we remove only 3 least significant bit-planes. Also, in the case when we reconstruct the image after removing 3 most significant bit-planes, a darker image with minute details of the original image is obtained.

Problem-2:
Takeaways - Histogram specification methods can be used to equalize the histogram of one image according to the histogram of another given image.

Problem-3:
Takeaways - The contrast of the image is enhanced when gamma transformation is applied. We can calculate the transformation map. After Fusing gamma transformed image and the original image, slight dehazing is observed.

Problem-4:
Takeaways - We found that weighted averaging is better than simple averaging because in the weighted average method, the relative importance of pixels is considered. It has better smoothening effects.