DAIICT

Assignment 3

Advanced Image Processing

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Task 1

Problem Statement

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

Figure 1

Library Used: NumPy

Method

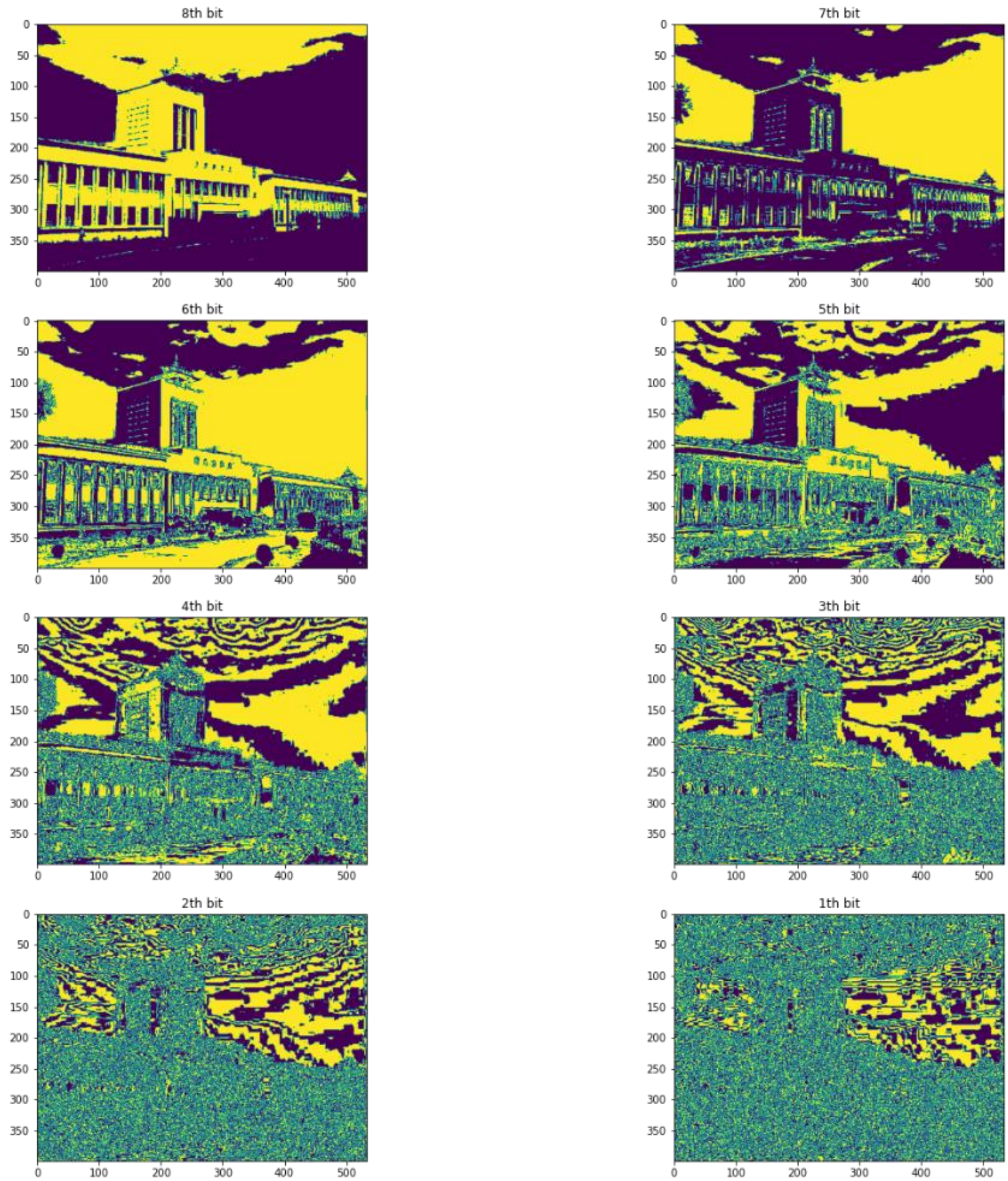
1. Binary Representation of Image
   numpy.binary_repr(num: int, width: Optional[int]) -> str

   Returns the binary representation of num in the form of a string.

   With this function, we converted each pixel value to their respective 8-bit representation by giving width=8 parameter with the pixel value.

Observation

1. Effect of different Bit plane slicing



2. Image reconstructed by removing three most significant bit plane

3. Image reconstructed by removing three least significant bit plane

Conclusion

- By removing the three least significant bit planes, the image reconstructed is close to the original image. Also, the image can be compressed by this method while preserving the quality.

Task 2

Problem Statement

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

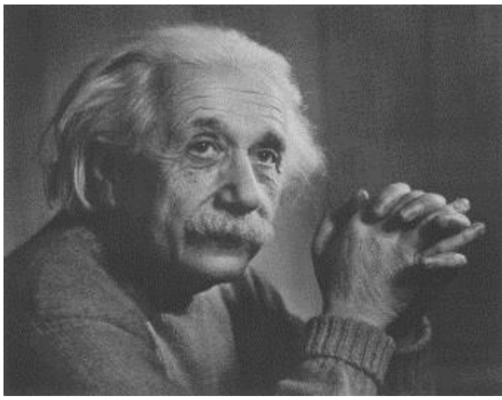


Figure 2 (a) **Figure 2 (b)**

Library Used: NumPy, scikit-image

Method

1. Histogram specification algorithm
   skimage.exposure.match_histogram(source image, reference image, multichannel)

   It will return the transformed image as like reference image.

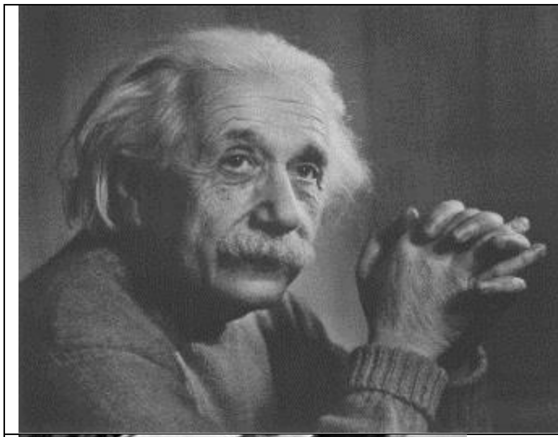
2. Computing Cumulative Distribution of histogram transformed Einstein image
   skimage.exposure.cumulative_distribution(image: array.pyi, nbins: Any = 256)

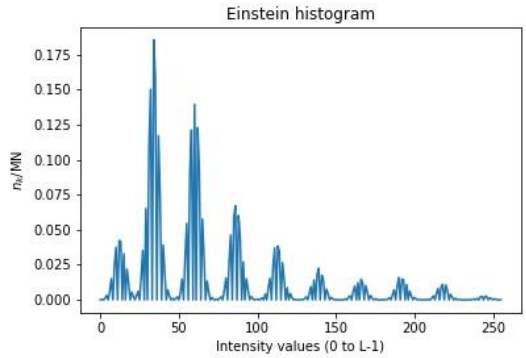
   Returns cumulative distribution (CDF) for the given image can be used to map old intensity values to new intensity values.

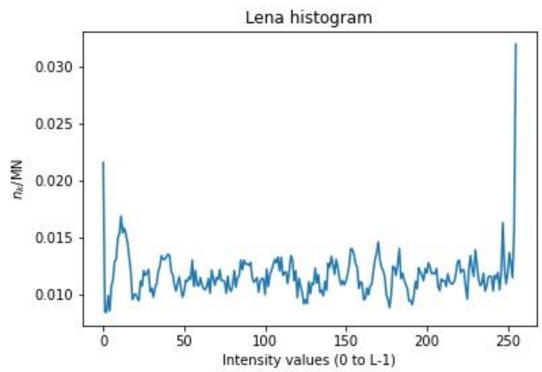
3. Intensity mapping function for original Einstein image to histogram matched image
   s[j] = T(r[j]) = floor ((L - 1) * CDF[j])

Observation

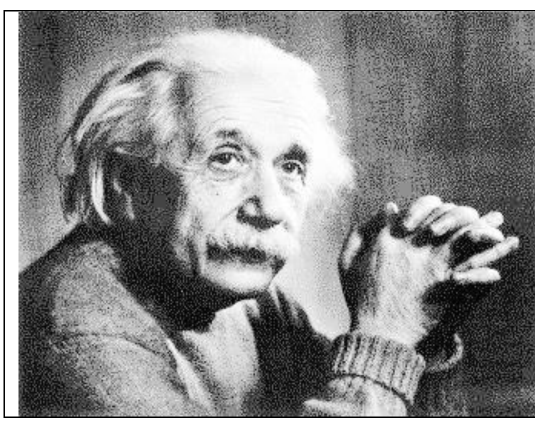
1. Source Image & It's Histogram

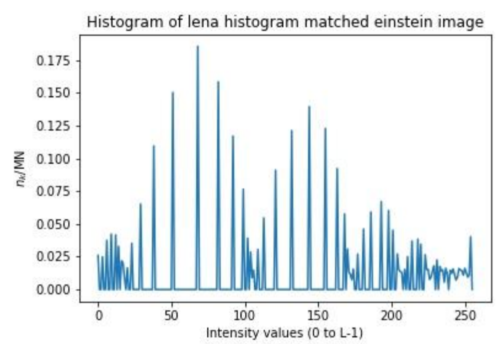




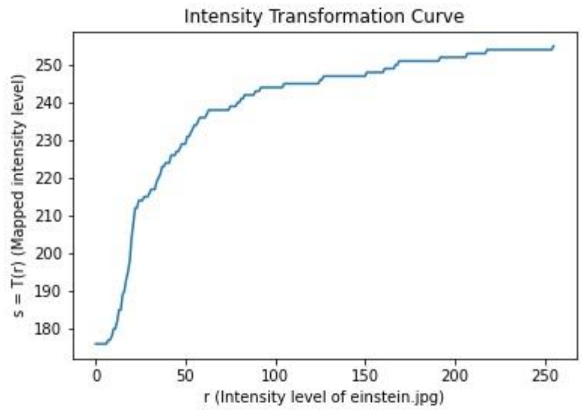


2. Histogram Transformed Image





3. Intensity transformation curve



Conclusion

By performing **Histogram Matching** on Einstein's image by referring to the histogram of Lena image, the resultant image was of higher contrast.

Task 3

Problem Statement

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 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 resultant image that have 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.

Figure 3 (a)

Figure 3(b)

Library used: OpenCV

Method

1. Histogram Equalization of image
   cv2.equalizeHist(image)

   It will return the histogram equalized image.

2. Gamma Transformation of image

   $$Img = Img^{\gamma}$$

   Where we have taken $\gamma = 1.5$

Observation

1. Gamma Transformation

2. Histogram Equalization

3. Gamma -> Histogram Transformation

4. Histogram -> Gamma Transformation

5. Estimated transmission map by using 6 x 6 window size (Ω = 6 x 6) Euclidean distance with given transmission map = 52869.89

Conclusion

- We have done estimation of transmission function by taking windows size 6 (larger window size will give blur image) for dark channel prior algorithm.