Fourier Series, Histogram Equalization (Updated)

Exercise 15 Download the audio signal 'audio.wav' from the exercise website. Use Matlab and the Fourier Transform to determine the frequencies contained in this signal, and the appropriate weights of the individual components.
Hint: To read in the signal, use `[signal,FS] = wavread('audio.wav')`.

Exercise 16 We examine the function $g(x)$, by comparing the exact solution to the approximation by a bandlimited Fourier series. $g(x)$ is given as

$$g(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} \tag{1}$$

   (a) Determine the Fourier transform $G(x)$ of $g(x)$ analytically.

   (b) Plot $g(x)$ and $G(x)$ in the interval $[-5; 5]$.

Exercise 17 Implement histogram equalization in Matlab or C++ and apply it to the images `Lena.png` and `LenaLowContrast.png`. Note that the first image is a 24-bit RGB image, whereas the second image is an 8-bit gray level image.
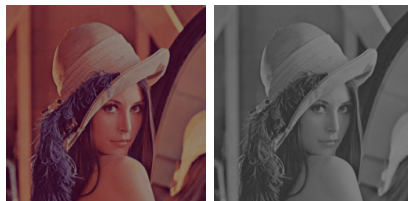
   (a) Briefly explain the idea of histogram equalization and what kind of effect it has on the contrast within an image.

   (b) Implement a function to calculate the cumulative density function for an input image.

   (c) Compute the mapping for the histogram equalization. Note that the output intensities should be within the same range as the input intensities.

   (d) Extend your methods to work also on multi-channel images (e.g. RGB) and apply the methods to the images.

   (e) The histogram equalization changes the color balance if it is directly applied to RGB. How can this problem be addressed?