Mathematisch- Naturwissenschaftliche
Fakultät

Fachbereich Informatik
Arbeitsbereich Visual Computing

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Bildverarbeitung I (Prof. Schilling)

WS2017/2018

Assignment 3, Due: 30. November 2017

Remarks

Please submit your exercises in ILIAS before 23:50 on the closing date. *Each* member of the group must be able to explain *each* exercise. Groups and members will be chosen at random and asked to present an exercise as a representative of the whole group. You should be prepared to explain any exercise at our biweekly tutorial.

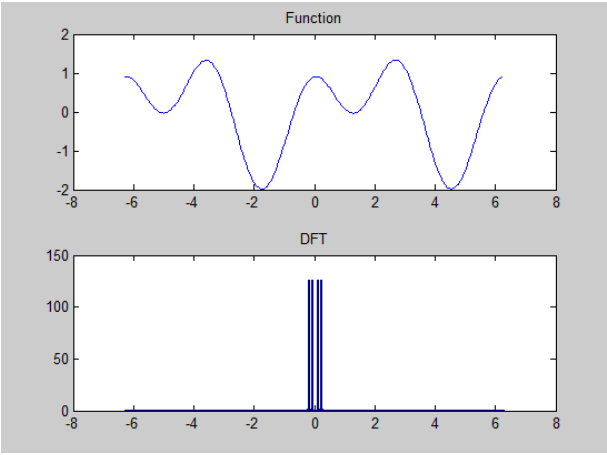
Matlab FFT howto

- Spectral analysis of a periodic signal can be done by transformation to Fourier space. Matlab's finite Fourier transform (`fft`) returns the sum of all signal values in X(1), then all positive frequency fractions followed by the negative ones.
- The Matlab functions `fft2` and `ifft2` can be used for discrete two-dimensional Fourier transforms of images. The function `displayfft2` displays the Fourier transform diagram of an image.
- For an intuitive visualization where the constant component is located in the middle, the return vector has to be re-sorted using `fftshift`.

Exercise 6: Discrete 1D Fourier transform [8 points]

a) DFT and iDFT [2 points]: Write two functions `my_DFT` and `my_iDFT` that compute the DFT and the inverse DFT for a 1D-vector.

b) Apply to simple functions [2 points]: Superimpose two sine waves with different frequencies. Compute the Fourier transform using your functions from the previous exercise and visualize the spectrum (centered around zero with frequencies scaled accordingly). The plot should look like this:



c) Simple denoising [2 points]: Add normally distributed random noise to your signal using `randn()`. Reconstruct the (noise free) original signal using the Fourier transform (and the inverse). Write a function `my_simple1DDFTDenoise` that applies a threshold in the frequency domain to denoise the signal.

d) Mean filtering [2 points]: Write two functions `my_1DBoxFilter` (that applies a mean filter in the spatial domain) and `my_1DBoxFilterDFT` (that applies a mean filter in the frequency domain). Compare the results and explain!

HINT: You can concatenate your periodic signal three times and use the middle section for filtering in the spatial domain in order to avoid a special boundary treatment.

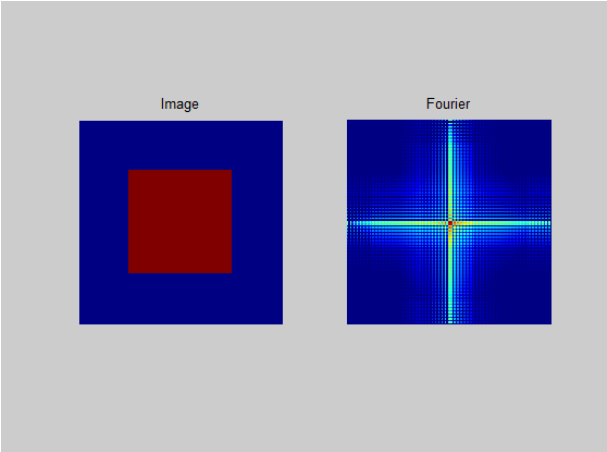
Exercise 7: Discrete 2D-FFT [4 points]

In this exercise the two dimensional function `f_Quad`

```
f_Quad = zeros(128,128);
f_Quad(32:96,32:96) = 1;
```

should be filtered in the frequency domain. You can use the built-in functions `fft2` and `ifft2` for this exercise. Use the function `displayfft2` to visualize the frequency spectrum.

- Write a function `my_plotFFT2D` that uses `displayfft2` and creates a plot that looks like the plot below.
  Explain the diagram created by `displayfft2`!



- Write functions `my_idealLowPassFilter` and `my_idealHighPassFilter` that implement ideal low- and high-pass filters in the frequency domain and apply these on the function `f_Quad`.