TNM087 - Image Processing and Analysis

Sharpness.m

Background:

Fourier theory can be used to analyze an ideal optical system (basically a lens). This is the topic of Fourier Optics (see Goodman, Introduction to Fourier Optics). The variation of the optical properties of an optical system when the focus setting is varied is modelled in optics (see Born & Wolf, Principles of Optics). Efficient autofocus algorithms are essential in many optical systems from consumer cameras to automated microscopy.

Intuitively a blurred image has a lower high-frequency content than a focused image. In this exercise we measure the mean frequency content of an image and investigate how it changes in a focus sequence. The image with the highest mean frequency should be in focus which can be verified by visual inspection.

Read Chap. 3.4 in Szeliski, Computer Vision for basic facts about the Fourier transform

Task:

From an image sequence defining a focus stack compute the Fourier based sharpness function

The sequence FStack can be loaded from the Matlab Mat-file AutoFocus32x32Patches.mat.

Syntax:

```
function sfunction = Sharpness(FStack)
```

Hints:

Read the description of fft2 and fftshift to understand which coordinate system is used by the fft functions in Matlab

The first step is to generate a series of rings with center at the origin of the Fourier domain.

You have to decide how many rings you want to use (8 is a reasonable choice since the images are small but you can play around with other choices)

Use only rings that are completely located within the Fourier domain (ignore corners)

Compute the number of grid points in each ring and save them for later use

For each slice in the stack compute the magnitude of the Fourier transform (don't forget the datatype)

Normalize the frequency content in the rings using the number of grid points in the rings. Now you have one normalized frequency content per slice, per ring

The last step is to combine the frequency content values for the rings in one slice to one number: the value of the mean frequency of that slice. How do you weight the contributions of the different rings?

You can try to generate a full-sized image where all pixels are in focus using the images I*.jpg. These images are found in the folder AutoFocusImages. Use different sizes for the patches. From the Mat-file data you can see that 32x32 worked there.