Computer Vision 1: Homework 5

Deadline 29.11. 12:15

Important: Submit your programming solutions through Moodle. The deadline for submitting your work is always on Thursday, at 12.15, the week after handing out the homework.
For other, non-programming homework, bring your solution with you to the exercise class. For each homework problem, one student will be chosen at random to present their solution.

Programming tasks.

As mentioned in the lecture slides, the correlation can be considered as a similarity measurement between two images. The `scikit-image` provides a function `skimage.feature.match_template` for computing the normalized correlation between two images. An example using this function can be found at `http://scikit-image.org/docs/dev/auto_examples/features_detection/plot_template.html`. In this exercise, we will use this function for finding clocks (instead of Waldo) in an image.

The clock template and the image can be downloaded from Moodle under the names `coco264316clock.jpg` and `coco264316.jpg`, respectively.

- Read the template and the image. Convert them to grayscale.
- Compute and visualize the matching result. Verify that the brightest pixel in the result corresponds to the clock.
- Flip the template horizontally. Verify that the clock can not be found.
- Flip the image horizontally. Verify that the clock can not be found.
- Match the flipped template to the flipped image. Visualize the result.

Other tasks.

1. Convolve the forward difference filter $\begin{bmatrix}-1 & 1\end{bmatrix}$ with itself, padding on both sides with zeros so the output has three elements. How can you interpret the result?

2. Using the two Sobel filters, compute the gradient magnitude for each pixel in image I:
$I = \begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}.$
Use zero padding so the result is the same size as I.

3. Starting from $G(x,y) = \exp\left(-\frac{x^2+y^2}{2\sigma^2}\right)$, derive the Laplacian $\nabla^2 G(x,y)$. Prove that
$$\nabla^2 G(x,y) = \nabla^2 G(x',y'),$$
where $x' = x\cos(\theta) - y\sin(\theta)$ and $y' = x\sin(\theta) + y\cos(\theta)$, where $\theta \in [0, 2\pi)$. What conclusion can be made from this result?

4. For a discrete signal
$$f[x] = \begin{cases}1 & x = 0,2\\ 0 & x = 1,3\end{cases} \quad \text{with length } M = 4,$$
find its M-point discrete Fourier transform $F[u]$ for $u = 0,1,2,3$. Sketch the result on the complex plane.