Computer Vision 1: Homework 9

Deadline 10.01.2019 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.

Download and read the image `Elbphilharmonie.jpg` on Moodle.

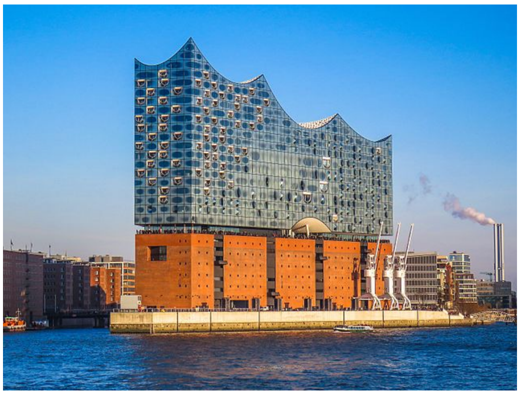

Figure 1: Hamburg Elbphilharmonie. Image source: Wikipedia

- Convert the image to grayscale image `im`.
- Using `numpy.fliplr`, flip the grayscale image horizontally to obtain a transformed image `im1`.
- Using `skimage.transform.AffineTransform`, obtain a transformed image `im2` with the following parameters: shrink the dimensions by half, 20 degree counter-clockwise rotation, 300 pixels to the right and 300 pixels to the bottom translation.
- Visualize all three images `im, im1, im2`.
- Using `skimage.feature.ORB`, extract 100 ORB key points and descriptors of the three images above. Visualize the matching results. In which transformation the matching works better?

  Note: ORB is an efficient alternative for SIFT. Follow the example at `http://scikit-image.org/docs/dev/auto_examples/features_detection/plot_orb.html`.

Other tasks.

1. The corresponding filters for computing D_{xx} and D_{yy} are $\begin{bmatrix} 1 & -2 & 1 \end{bmatrix}$ and $\begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}$, respectively. These filters are obtained by convolving the 1st-order derivative filters by itself with proper zero-paddings: $\begin{bmatrix} 1 & -1 \end{bmatrix} \star \begin{bmatrix} 1 & -1 \end{bmatrix} = \begin{bmatrix} 1 & -2 & 1 \end{bmatrix}$, $\begin{bmatrix} 1 \\ -1 \end{bmatrix} \star \begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}$.

Using similar approach, compute $D_{xy} = D_{yx} = \begin{bmatrix} 1 & -1 \end{bmatrix} \star \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. The result should be a 2×2 matrix.

2. It was mentioned in the lecture that for $r > 0$, the function $f(r) = \frac{(r+1)^2}{r}$ has a minimum at $r = 1$. Prove this claim.

   Note: the reason why $r = \frac{\alpha}{\beta} > 0$ is because the key points are extrema, hence the (symmetric) Hessian matrix at a key point has to be either positive definite (when the key point is a minimum) or negative definite (when the key point is a maximum). See how wonderfully all the maths come together!