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BM40A0901 Computer Vision
Exercise 6, February 16, 2017.
More features: difference of Gaussians, HT for lines.

1. Scale invariant interest points (2 points)

   The goal of this task is to detect local scale invariant features from an image. Use the grayscale Lena image (lena_bw.png).

   The local features are found using the difference of Gaussian (DoG). The difference of Gaussian is defined as

   $$D_i(x, y) = I(x, y) * G_{\sigma_i} - I(x, y) * G_{\sigma_{i+1}}$$

   where $I(x, y)$ is the original image, G_{σ_n} is the Gaussian, and $*$ is convolution. When several values for σ are used, then a stack of images is constructed as

   $$D(x, y, i) = D_i(x, y)$$

   - Use various values for σ_i to construct the stack $D(x, y, i)$. One selection for parameters σ_i could be $\sigma_{i+1} = \sqrt{2}\sigma_i$ with $\sigma_1 = 3$.
   - The local features can be found as a local maximum of D. For 3D matrices local maximum means that the sample (x, y, i) is the largest within its neighbourhood, i.e. it is larger than its 26 neighbours (8 neighbours in level i, 9 neighbours in level $i + 1$ and 9 neighbours in level $i - 1$).
   - Find the local mimimum using the same approach. How do the maximum differ from the minimum?
   - Plot the locations of the local maxima in the original image.
   - Extra feature! The number of local features can be delimited with thresholding. Use $thresh = 10$ in finding local features.
   - Extra tests! What happens if the image is subsampled? What if the image is rotated with $\alpha = 45^0$?

2. Hough transform and noise (1 point)

   This task is concentrating in the effect of noise in the Hough transform.

   Familiarize yourself with the implementation of the Hough transform found in the Image Processing toolbox of Matlab (HT), check the functions `hough, houghpeaks, houghlines`). Which parameters can be specified in the implementation?

   Download the block image (blocks-bw.png). Perform edge detection with the Canny edge detector (using `edge`-function in Matlab).

   Use the implementation of HT to detect lines in the edge image, tuning the parameters as necessary. How many peaks (local maxima) do you need in order to

find all of the most significant lines in the image? Which are the values for other parameters to get this result?

Now, find out experimentally how much salt-and-pepper noise can be added to the edge image, while still getting a satisfying line detection result in Hough Transform with the same parameter values as before?

3. Hough transform for circles (1 point)

   Now the task is to apply Hough transform for circles. Use the function `imfindcircles` given in Matlab.

   Apply the function to the following two images: Coins-1 and Coins-2. How many coins can be detected from each image?

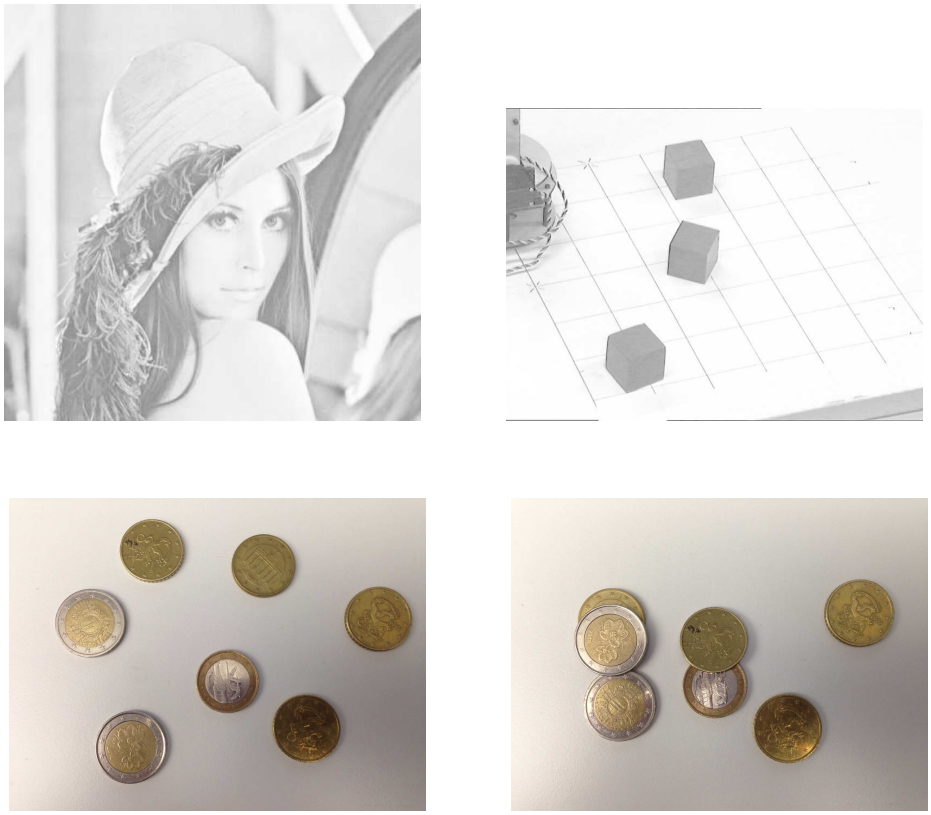

Figure 1: Images in the experiments. Top row: left, Lena image; right: Blocks. Bottom row: left, Coins-1; right, Coins-2.