Exercise 03 for MA-INF 2201 Computer Vision WS19/20
27.10.2019
Submission on 02.11.2019

1. **Hough Transform**

   Read the image `shapes.png`.

   (a) Detect the lines by a Hough transform using `cv2.HoughLines`. Visualize the detections by drawing lines on the image.

   (b) Implement the function `myHoughLines` and use it to detect the lines. Visualize the detections and the accumulator.

   (5 Points)

2. **Mean Shift**

   Read the image `line.png` and use your implementation of `myHoughLines` to get the accumulator of the detected lines in the image. Then implement the mean shift algorithm to find the peaks in the accumulator. Visualize the accumulator and the lines corresponding to the peaks.

   (For more details: *D. Comaniciu and P. Meer. Mean Shift: A Robust Approach Toward Feature Space Analysis. IEEE Transactions on Pattern Analysis and Machine Intelligence 2002.*)

   (5 Points)

3. **K-Means**

   Implement the function `myKmeans` and then use it to segment the image `flower.png` based on:

   (a) Intensity,

   (b) Color,

   (c) Intensity and (properly scaled) image position.

   Visualize the results for all three cases with $k = 2, 4, 6$.

   (5 Points)

4. **Graph Cuts**

   Consider the graph shown in Figure 1 to answer the following questions:

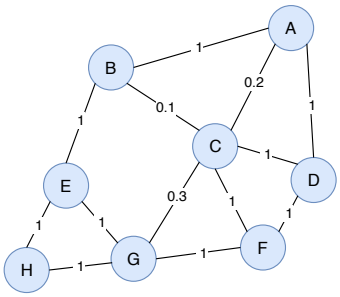

Figure 1: A simple graph. The weights are specified on the edges.

(a) Compute the eigenvector y corresponding to the second smallest eigenvalue of the following generalized eigenvalue problem

$$(D - W)y = \lambda Dy$$

where W is the affinity matrix of the graph and D is a diagonal matrix that contains the degrees of the vertices.

Hint: use `cv2.eigen` *to solve the equivalent standard eigenvalue problem*

$$D^{-\frac{1}{2}}(D - W)D^{-\frac{1}{2}}z = \lambda z \; ; \quad z = D^{\frac{1}{2}}y$$

(b) Use the result of part (a) to find the minimum normalized cut $\mathrm{NCut}(C_1, C_2)$. The sign of the values in the eigenvector computed in (a) determine the separation of the vertices into the two clusters C_1, C_2. List the nodes in each cluster and compute the cost of the normalized cut.

(5 Points)