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Lappeenranta University of Technology
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BM40A1200 Digital Imaging and Image Preprocessing

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Exercise 12: Colours and image processing

1. Response to colour stimulus (1 bonus point): Let us assume natural daylight as the ambient illumination, modelled with the Commission Internationale de l'Eclairage (CIE) standard illuminant D65, and an object for which we have spectral reflectance information. The file for the illuminant contains the columns `lambda,D65` where `lambda` is the wavelength.

   (a) Based on the given spectral sensitivities for the cones in the eye , what are the cone responses when we are looking at the object? The columns in the file are `lambda,R,G,B` where `lambda` is the wavelength.

   (b) Based on the given spectral sensitivities for a red-green-blue (RGB) camera with a Bayer filter, what are the responses of the elements in the sensor array? The columns in the file are `lambda,R,G,B` where `lambda` is the wavelength.

   Hints: For example, you can go to Spectral Color Research page of the University of Eastern Finland, Joensuu, go to Databases & software, and download the spectral color database for Candy colors for the experimentation.

   Additional files: `camera.csv, ciexyz31.csv, cones.m, D65.csv`.

   Additional resources: `csvread, interp1`.

2. Colour image noise (1 point): Select a colour image, for example, from the set of "standard" test images.

   (a) Distort the image with salt-and-pepper noise and normally distributed noise by using a few different parameters (increasing the noise level). How to implement the distortion since RGB have three colour channels? When the approach has been selected, implement it, perform the distortions and visualise the results.

   (b) Determine the signal-to-noise ratio (SNR) of all the images including the original one (if possible), and present the results.

   (c) Experiment with a suitable image filter to remove the noise, and present the related SNRs.

3. Colour measurement (1 point):

   (a) Prepare a synthetic colour image containing geometric shapes. Distort the image with suitably distributed noise to simulate the effect of imaging with a modern digital camera. Visualise the image with and without noise.

   (b) If the purpose of imaging would be to measure the colour of an object in the image accurately, how is it possible to do it? Carry out an experiment with the selected approach and present the results.

   (c) How is it possible to select an object from the image automatically? Does the approach have any assumptions or limitations?

4. Spatial unevenness of image intensity (1 point): Due to various reasons, the image intensity values can be unevenly distributed is space.

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(a) Study the provided image shown in Fig. 1. What kind of model can be used represent the uneven intensity field?

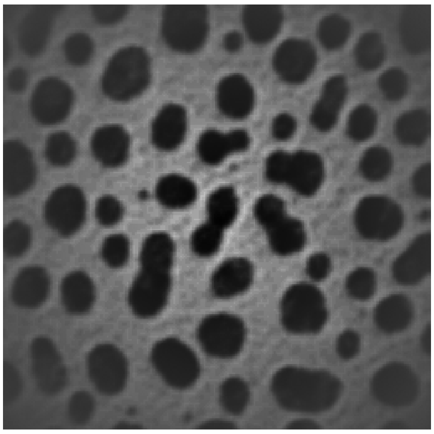

Figure 1: An image with blobs.

(b) Experiment in Matlab with the correction of the intensity field. Try to make the intensity distribution as flat as possible.

Additional files: `t021a.png`

5. Thresholding and region features (1 bonus point):

(a) Study the histogram of the provided image shown in Fig. 2. Based on the histogram, make the first guess for a suitable threshold for segmenting the image into objects and background (justify your guess).

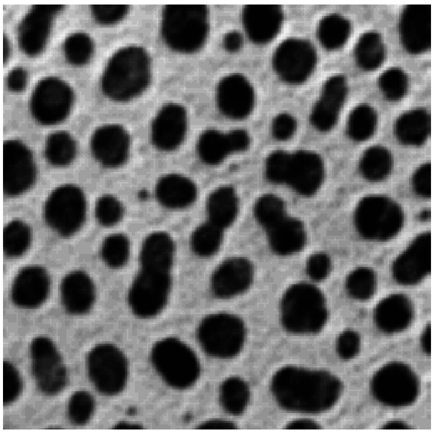

Figure 2: An image with blobs.

(b) Use the Matlab function `graythresh` to determine the optimal threshold, and segment the image.

(c) Experiment with the Matlab function `regionprops`. At least plot the region center points on your segmented image, with a distinct marker for the region with the largest area.

Additional files: `t014a.png`