Digital Signal Processing
Instituto Superior Técnico
Lab assignment 5 – Image Segmentation
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Introduction

In this assignment, we will address image segmentation using Maximum Likelihood Estimation. The goal is to compare several distributions for the image intensity and to use the one that best fits the given image data to perform segmentation.

Notes

In this assignment, you'll often find between brackets, as in {`command`}, suggestions of Matlab commands that may be useful to perform the requested tasks. You should use Matlab's help, when necessary, to obtain a description of how to use these commands.

Experimental work

1. **Maximum Likelihood Estimators.**

   R1.a) Find the log-likelihood function and the Maximum Likelihood estimate of the unknown parameter(s) for each of the following univariate distributions:

   a) Exponential distribution. b) Rayleigh distribution. c) Normal distribution.

   R1.b) Load the image data {`sar_image`} which contains a Synthetic Aperture Radar (SAR) Image depicting ice and ocean. Visualize the image. {`imagesc, colormap`}

   R1.c) Crop two image regions, as large as possible, one in the ice area and the other in the water area. Use the pixels intensity in each of the cropped regions as observations and estimate the unknown parameter(s) that best fit your data, for the designated distributions. Indicate the parameters you obtained. You may use Matlab's functions for maximum likelihood estimation. {`imcrop`}

   R1.d) Plot each of the estimated distributions and compare with the histogram of the image data, properly normalized, in both regions (water and ice). Which distribution do you think is the best? {`histogram`}

2. **Image Segmentation**

   R2.a) Use the parameters you estimated for the best distribution to perform segmentation of the image by assigning each image pixel to the region (water or ice) with maximum log-likelihood. Show the segmentation results superimposed on the image. {`imcontour`}

   R2.b) Repeat R2.a) but now assign each image pixel to the region (water or ice) with maximum log-likelihood, when computed in a 9x9 patch around each pixel. Assume the pixels in the patch are independent.

   R2.c) Segment the image with thresholding. Select the threshold from the plots of the chosen intensity distributions for water and ice.

   R2.d) Compare the previous approaches visually and by computing their rate of correct decisions in the regions used for parameter estimation. Comment.