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Examination in Statistical Image Analysis, March 12, 2003

Course code Chalmers: TMS016, Gothenburg University: Statistisk Bildbehandling

Written examination March 12, 2003, 8.45-12.45 in house V.

Literature and notes may be brought for this written examination. All types of pocket calculators are allowed but not computers. In the written examination there are two problems. You are supposed to answer both of them, and in the judgement they have the same weight. Answers may be given in English or Swedish.

Problem 1.

Figure 1 below shows two images obtained from an experiment where ultrasound is used to locate inclusions in a steel specimen. Inclusions detected lie between 0.9 and 1.1 mm below the surface of the specimen. The steel has been rolled in a direction corresponding to the horizontal direction in the images. Inclusions are typically caused by small amounts of sulphur or oxygen and may start fatigue cracks when the steel is used in constructions and is subject to stress. Each white spot (blob) is supposed to correspond to one inclusion. (There are about 7 spots in the left image and about 9 spots in the right image.) For each specimen one has one image with about 9000 rows and 5000 columns and the images in Figure 1 are actually subimages of one such large image. Each pixel corresponds to an area of about $10^{-6}m \times 10^{-6}m$.

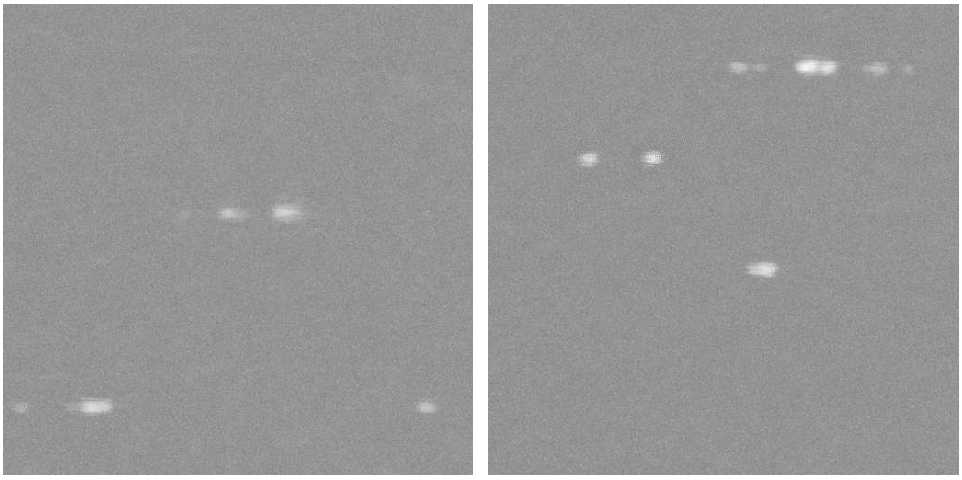

Figure 1: Two 512×512 images from an ultrasound experiment.

a) Suggest a method for counting the number of spots in images such as those in Figure 1. Describe also how one can estimate a position for the centre (suitably defined) of each spot.

b) One is also interested in estimating the size and shape of the spots. Suggest some method for doing this.

c) Suggest one method (or several methods) to test if the spots are placed in a purely random manner in the rectangles regarded. Looking at the images, do you expect deviations from a purely random placement of the spots?

Problem 2. Suppose that for 10 individuals we have 20 photos acquired at different occasions. All photos are supposed to be taken en-face (from forward) as shown in the left part of Figure 2, where one photo for each of the persons is available. Suppose that we also have an image analysis programme that can identify 16 landmark points on a face as shown in the right part of Figure 2. The object is now to describe a method that together with a camera may be used for automatic discrimination between the 10 persons by use of suitable functions of the 16 landmarks. (For simplicity we only regard these 10 persons here.)

Figure 2: Left: face images for 10 persons. Right: 16 landmark points (marked with small circles).

a) Suggest three size-dependent features that may be tried for discrimination, that is should be useful if the distance between the camera and the persons photographed is constant. Describe the computation of these features from the landmarks. Describe in words how you may implement the computations (without giving programmes) in a programme system like matlab.

b) Suggest three size-independent features that may be tried for discrimination.

c) Give a statistical model for the landmark data for the 10×20 images. How would you estimate parameters in the model?

d) Suggest a method for finding a suitable set of features for solving the discrimination problem with a low error rate.