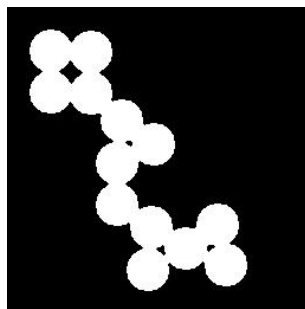


Tutorial: Morphological Watershed

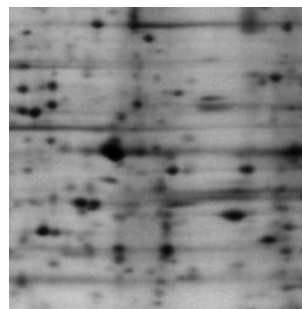
Note

This tutorial aims to study the watershed transform for image segmentation. In image processing, an image can be considered as a topographic surface. If we flood this surface from its minima and if we prevent the merging of the water coming from different sources, we partition the image into two different sets: the catchment basins separated by the watershed lines.

The different processes will be applied on the following images:



(a) circles



(b) gel

1 Watershed and distance maps

The objective is to individualize the disks by disconnecting them with the distance map.



- Calculate the distance map of the image 'circles'.
- Take the complementary of this distance map and visualize its minima.
- Calculate the watershed transform of the inverted distance map.
- Subtract the watershed lines to the original image.

**Informations**

The distance map can be calculated by `bwdist` on a binary image, the local minima are evaluated by `imregionalmin`.

2 Watershed and image gradients



- Calculate the Sobel gradient of the image 'gel'.
- Visualize the minima of the image gradient.
- Apply the watershed transform on the gradient image.

The watershed transform, applied in a direct way, leads to an over-segmentation. To overcome this limitation, the watershed operator can be applied on a filtered image.



- Smooth the original image with an alternate morphological filter (opening followed by closing).
- Calculate the gradient operator on the filtered image.
- Calculate the corresponding watershed.

**Informations**

The mathematical morphology function of opening and closing are `imopen` and `imclose`.

3 Constrained watershed by markers

In order to individualize the image spots, we have to determine the internal and external markers for the constrained watershed.



- Calculate the gradient (Sobel) of the filtered image.
- Calculate the internal markers (minima of the filtered image) and external (watershed of the filtered image) as minima of the gradient image.
- Calculate the corresponding watershed.

- Superimpose the watershed lines of the resulting segmentation to the original image.



Informations

`imgradient` returns the gradient magnitude of an image. `imimposemin` is used to impose minima to an image in order to perform watershed segmentation.