

## The watershed algorithm

Practice work #3 - Arnaud QUIRIN - May 2008

The goal of this practice is to implement the watershed algorithm. This algorithm is really famous in image analysis, even if its quality has been outperformed now by many other algorithms. This algorithm is used to make segmentation, that is to separate the image in regions. This process is not the same as doing categorization, because we have no idea about the relationships between two different regions (they could be viewed as independent regions, they do not share the same concept).

Anyway, the watershed algorithm has been proved to be very useful in many areas of image analysis, and its still used nowadays, combined with other algorithms. If you need more information, you will have to look the paper of Digabel and Lantuejoul (1978).

The watershed algorithm splits the image into regions similar to the drainage regions of a landscape. If the intensity of the image is interpreted as elevation in a landscape, the watershed algorithm can then be used to find mountains, lakes and catchment basins in this landscape. This can serve as a ground for segmentation algorithms, but it can also be a useful tool for describing the internal structure of objects.

The watershed segmentation can be thought of in the following way. Given that the intensity image is interpreted as a 2D surface in a 3D space, where the intensity encodes the height coordinate. We take this surface and pierce a small hole at every local minimum of the surface. We then slowly immerse the surface into a container filled with water. The water will start to rise from the small holes at the minima of the image. As the water level rises, water from adjacent minima will eventually meet. At the border where the water meets, we build a dam, to prevent the mixing of the water from the different minima. We immerse the surface further until we have a pattern of dams covering the image. These are the watersheds, surrounding the catchment basins of the respective local minima. This separation of the image into catchment basins is what we will refer to as watershed segmentation. The border between adjacent catchment basins will be at the ridges in the intensity landscape.

Watershed segmentation can be implemented with sorted pixel lists so that essentially only one pass through the image is needed. Once implemented, this algorithm should be really fast. Implement it and try it on the images provided, using the ImagePPM library.

For which kind of images this algorithm gives better results ? Why ?

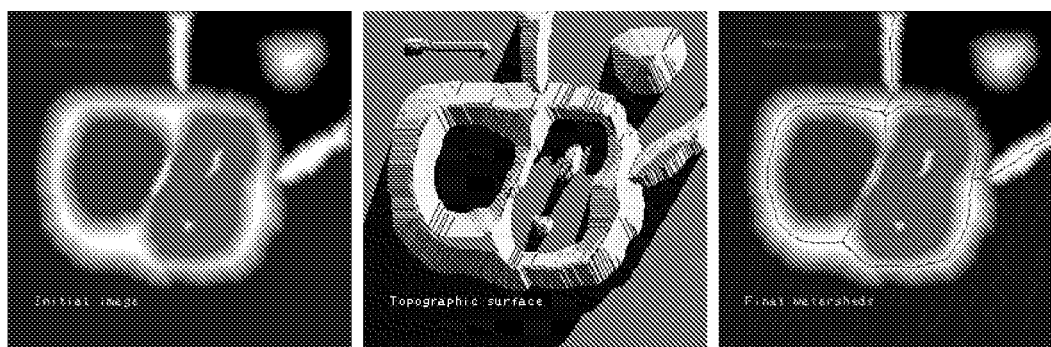


FIG. 1 – The idea of the watershed algorithm : the initial image (in black and white), its representation in 3D and the result.