

# AUTOMATIC MARKER DETERMINATION ALGORITHM FOR WATERSHED SEGMENTATION USING CLUSTERING

M. A. GONZALEZ<sup>†</sup> and V. L. BALLARIN<sup>†</sup>

<sup>†</sup> *Signal Processing Lab., Electronics Engng. Department, Universidad Nacional de Mar del Plata / CONICET  
mazulgonzalez@fi.mdp.edu.ar*

**Abstract**— Biomedical image processing is a difficult task because of the presence of noise, textured regions, low contrast and high spatial resolution. The objects to be segmented show a great variability in shape, size and intensity whose inaccurate segmentation conditions the ulterior quantification and parameter measurement. The partition of an image in regions that allow the experienced observant to obtain the necessary information can be done using a Mathematical Morphology tool called the Watershed Transform (WT). This transform is able to distinguish extremely complex objects and is easily adaptable to various kinds of images.

The success of the WT depends essentially on the existence of unequivocal markers for each of the objects of interest. The standard methods of marker detection are highly specific, they have a high computational cost and they determine markers in an effective but not automatic way when processing highly textured images. This paper proposes the use of clustering techniques for the automatic detection of markers that allows the application of the WT to biomedical images. The results allow us to conclude that the method proposed is an effective tool for the application of the WT.

**Keywords**— Image segmentation, Watershed transform, Mathematical morphology, Pattern recognition.

## I. INTRODUCTION

Biomedical images are formed by objects with a high variability in shapes, sizes and intensities (Glasbey and Horgan, 1994). They are highly textured and have a high level of noise, low contrast and great spatial resolution. Watershed Transform (WT) is a powerful morphological tool to segment textured images into regions of interest. This transform is adaptable to different types of images and capable to distinguish extremely complex objects.

The WT is a segmentation method based on regions, which classifies pixels according to their spatial proximity, the gradient of their gray levels and the homogeneity of their textures. To avoid over-segmentation a single marker for each object of interest has to be selected.

Classical Watershed Transform is based on regional minima to initiate the flooding algorithm. That is the reason why this classical method produces oversegmentation in textured images. Unlike the classical W.T. that

uses regional minima, the marker-based Watershed Transform uses binary markers to start the flooding algorithm.

The selection of adequate markers on these kinds of images is a painful and sometimes unsuccessful task. Hence, the experienced observer uses to define markers in a semiautomatic way (Gauch, 1999; Jackway, 1996; Wang, 1997). The automatic determination of markers is still a difficult goal to achieve. The current determination algorithms are highly dependent on the structure to be segmented (Gorsevski *et al.*, 2003; Li and Harnaneh, 2007). Moreover, they have a high computational cost and they determine markers in an effective but not automatic way when processing highly textured images (Gonzalez and Ballarin, 2006a; Gonzalez and Ballarin, 2006b).

In this work, we present a two-step watershed algorithm for biomedical image segmentation. The main contribution of this work is that the markers are selected by a clustering technique applied to the oversegmented watershed regions.

First we applied the classical WT using the regional minima as markers. Then we measure texture features inside each region. We applied a cluster algorithm to assign to each region one class. WT markers are selected as the cluster that represents the objects of interest. Finally a marker-based WT was applied to the gradient of the original image using the markers computed previously. The results showed an effective and robust segmentation of highly textured images.

## II. METHODS

### A. Watershed Transform

A gray scale image can be interpreted as the topographic image of landscape (gray intensities of higher amplitude correspond to plains and mountains and the lower intensity ones correspond to valleys and rivers) (Clasteman, 1979; Glasbey and Horgan, 1994; Gonzalez and Woods, 1996). Using the features of these images, the technique of digital image processing called Watershed Transform (WT), which through the flooding of the valleys, is capable of recognizing similar topographical areas, surrounded by mountain ridges. The WT is a segmentation method based on regions, which classifies pixels according to their spatial proximity, the gradient of their gray levels and the homogeneity of their textures (Beucher and Meyer, 1993; Couprie and Bertrand, 1997; Vincent and Soille, 1991).

With the objective of segmenting a gray level image, prior to the application of the WT, a gradient image