Trajectory-based morphological operators: a model for efficient image processing

Antonio Jimeno-Morenilla[1], Francisco Pujol-López[1], Rafael Molina-Carmona[2], José L. Sánchez-Romero[1], Mar Pujol-López[2],

jimeno@dtic.ua.es; fpujol@dtic.ua.es; rmolina@dccia.ua.es; sanchez@dtic.ua.es; mar@dccia.ua.es

[1]Departamento de Tecnología Informática y Computación, Universidad de Alicante
[2]Departamento de Ciencias de la Computación e Inteligencia Artificial, Universidad de Alicante
Carretera de San Vicente, s/n. 03690 – San Vicente del Raspeig, Alicante (Spain)

Abstract

During the last years, many different improvements have been proposed in order to implement morphological operations in a more efficient way. The classical morphological model has a non-deterministic nature, defined over elements of a set without order restrictions in the access to these elements. We present the Morphological Trajectory Model (MTM), in which morphological operations are restricted to support an order. This order will represent the structuring element trajectory. Therefore, an order relation between sets elements will be incorporated so that a sequence of operations could be established and, therefore, a deterministic component will be added to the morphological paradigm.

A morphological operation will be divided into a sequence of unitary or *basic* operations. This sequence will guarantee the resulting order of the whole operation. Since every basic operation will correspond to a particular position of a structuring element along a trajectory that is performed during a period of time, we call them *instant basic operations*.

When applying the classical Mathematical Morphology to image processing, calculations are made on a complete image. That is, the morphological operator does not distinguish whether the pixels belong to a specific object or not: it simply applies a calculation of supremum or infimum in a neighborhood environment. In the MTM, it is necessary to differentiate between the objects given in the space, since each object has a different geometric representation. Furthermore, this representation defines the frontier of the object and not its inner part. Another difference is the representation of the structuring element: whereas in traditional morphology it is treated as a subset of points (which is discretized when working with images), the MTM considers the geometric function of the points which make up its frontier, so discretization is not required.

Several experiments were carried out so as to obtain the computation time under different input conditions. Both the size of the object and the size of the structuring element were varied, as well as the parameters which took part in the morphological operation. The computation time of the MTM remains almost constant against the variations in the size of the structuring element; this is due to the fact that we use its geometric representation instead of its content. There is no significant increase in the MTM computation time when the size of the structuring element is increased, since this variation is minimal compared to the morphological methods.

The MTM offers an efficient alternative to traditional methods for computing morphological primitives. The application of MTM is justified when the number of points of the objects and that of the structuring elements is high. The independency from the structuring element size makes the application of morphological operations interesting on high definition images or 3D image reconstruction. The new model has been conceived for binary 2D images. However, the new paradigm is extensible for any number of dimensions of the Euclidean space.