Abstract

Mathematical morphology has gained wide popularity both in its applications to various problems relating to computer vision and in the development of its theory. Morphological methods have been applied to fields as diverse as pre-processing, filtering, thinning, shape description and characterization, bio-medical image processing, industrial vision, texture analysis, object recognition, etc. Numerous architectures have been developed which incorporate morphological operations. Recent investigations into the theory use lattices to model morphological operations. This greatly extends the scope of the morphological methods.

In this dissertation we have presented the design of some algorithms addressing various image processing tasks, and the implementation of the algorithms in terms of operations of mathematical morphology. The selected set of algorithms include gradient directed filters, medial line extraction of 2-D images, segmentation of range images and region merging in 3-D images using the lattice formulation of morphology.

Gradient directed filtering is a modification of the Minkowski operations, which selectively smooth an image based on the local gradient information. A number of theoretical aspects, such as translation invariance, increasing

properties and decomposability have been addressed. A hardware implementation has also been suggested.

We have suggested a parallel approach for the extraction of the medial axis, using a modified 4-neighbor distance transform to pre-mark the object pixels. Proofs of continuity have been provided. The algorithm has been tested on a number of binary objects and has been found to produce skeletons which are virtually one pixel thick. Our algorithm has also been shown to be invariant to rotation.

We have also suggested a morphological method for segmentation of range images from neighborhood properties. Each pixel is characterized by the orientation of the plane that best fits its locality. Region growing is accomplished on the labelled image using conditional dilation. The process of extraction of the neighborhood properties is completely parallel.

In the last application, we use the lattice formulation to model a description of labelled 3-D voxel images. Subsequent morphological operations are shown to result in a merging of neighboring regions having similar labels, which leads to a reduction in the number of regions in the segmented 3-D image.