Threshold Dynamics for Shape Reconstruction and Disocclusion

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Many well known models of computer vision and image denoising involve minimizing a curvature dependent functional over all curves in the plane. An important example is the 2.1D sketch model of Mumford, Nitzberg, and Shiota for segmentation with depth, which includes a difficult term of the form

$$\int_C k_C^2 + \alpha \, d\sigma$$

where k_C denotes the curvature of the curve C, α is a positive constant, and dσ denotes the length element.

This model can be used to reconstruct boundaries of occluded regions in images, as illustrated in the simple examples on the right: They depict a disk and a diagonal bar, parts of which are blocked from view by the noisy squares shown. Standard techniques for minimizing such energies using the level set method lead to fourth order nonlinear PDEs that are computationally very costly to solve. Following up on previous work by Merriman, Bence, and Osher, by Esedoglu and Tsai, and by Grzibovskis and Heintz, we developed algorithms that reduce the solution of the nonlinear PDE to alternating convolution with a kernel and simple thresholding. This results in a very fast algorithm that gives reconstructed boundaries shown in the second column on the right.

Image of Occluded Shape

Reconstructed Boundary

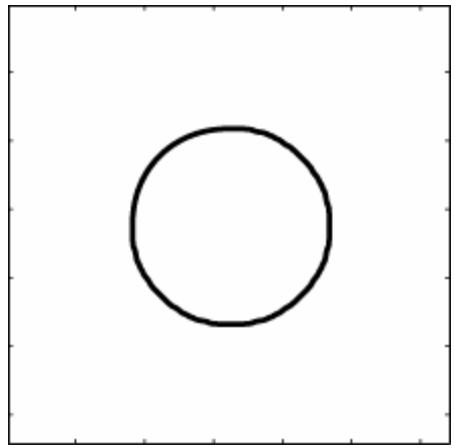
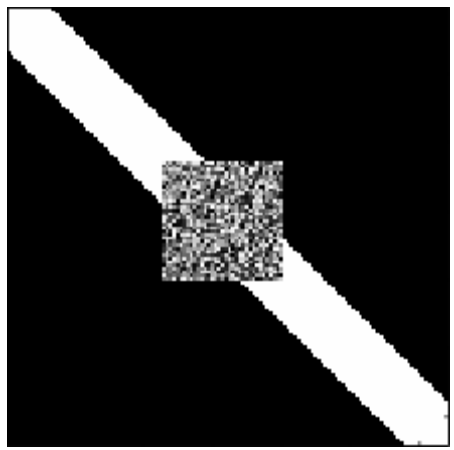


Image of Occluded Shape



Reconstructed Boundary