Image Thresholding

This is one of the oldest problems in automated image analysis. Essentially there are two types of thresholding available to date: global thresholding and locally adaptive thresholding. Often, due to the variability in the gray level intensities and because of noise, the global thresholding does not work satisfactorily. So you typically resort to locally adaptive ones. The locally adaptive thresholding methods build a threshold surface that is a function on the image domain. Next, you threshold the image with this threshold surface. There are plenty of methods out there that build this locally adaptive threshold surface. However, typically you pay a price here– the laborious selection of various tuning parameter values in these algorithms. We wanted to mitigate this effort of parameter tuning. That is why we build a locally adaptive image thresholding algorithm we call **Variational Minimax** algorithm. It is based on minimizing an energy functional. This energy functional has **no tuning parameters!** So, why would one care about thresholding, when we know that it cannot replace segmentation methods? I often face this question. My answer is the following. If you look at sophisticated segmentation algorithms, you'll notice that many of them require some sort of initialization and their performance almost always depends on how good these initializations are. Adaptive thresholding methods can serve the purpose of initialization for these algorithms. Some results below show a quick qualitative comparison (click on the pictures to see bigger images). Try the Matlab code. Here's our paper in ICIP 2007. The energy functional in this paper has one tuning parameter, which we have removed later.

Barbara image

A global thresholding method: Otsu's method [1]

A locally adaptive thresholding algorithm: Liu *et al.*'s method [2]

The proposed algorithm: Variational Minimax method

References

[1] N. Otsu, "A threshold selection method from gray– level histogram," *IEEE Transactions on System Man Cybernatics*, Vol. SMC-9, No.1, pp. 62-66, 1979.

[2] F. Liu, Y. Luo, X. Song, D. Hu, "Active surface model-based adaptive thresholding algorithm by repulsive external force," *Journal of Electronic Imaging*, vol.12, pp.299-306, 2003.