23. Grey-level to binary images - why?

A. Find objects quickly
B. Look for shape
C. Differentiate between strong and weak edges
D. Pseudo grey for printing - half-toning

General methods used to obtain binary images

1. Filter noise: (Median filters, erosion, blurring)
   - Generally better
2. Manipulate histogram: contrast stretching
3. Enhance edges (you may not want to use sobel like works or laplacian)
   - Because tends to generate noise, consider using unsharp filter
4. Threshold image

   - Global fixed $T$ or multiple $T_i (T_1, T_2, T_3 ...)$
   - Local fixed $T_{ij}$

   Image broken up into areas, each area has a different threshold based on histogram or intensity

\[ f(p) \]

- Single threshold histograms

\[ f(p) \]

- Multiple thresholds

(See p. 578-583, Gonzalez Woods 2nd ed.)

- Local variable threshold based on local \( \nabla f \) and/or \( \nabla^2 f \). Noise can be a problem.
4. Threshold (Continued)

Local:
- Variable threshold based on mean + σ_local

\[ T = \bar{I} \pm \sigma \]

(a) fixed threshold
\[ T = \bar{I} \]

(b) variable threshold
\[ T = \bar{I} \pm \sigma \]

Figure 56. Variable thresholding: The idea is illustrated in one dimension on the left. Clockwise from top left for the image on the right: An original star cluster image with a varying background, a high global threshold identifying stars close to the cluster center, a low threshold identifying stars far from the center, and a variable threshold identifying stars.

5. Image Subtraction: \[ I_2 = I_1 - I_0 \] then use thresholding techniques. Works well if background is stationary (see G.Woods, p. 110, 2nd Ed.).
FIGURE 3.28
(a) Original fractal image. 
(b) Result of setting the four lower-order bit planes to zero. 
(c) Difference between (a) and (b). 
(d) Histogram-equalized difference image. 
(Original image courtesy of Ms. Melissa D. Binde, Swarthmore College, Swarthmore, PA).
FIGURE 3.29
Enhancement by image subtraction.
(a) Mask image.
(b) An image (taken after injection of a contrast medium into the bloodstream) with mask subtracted out.
FIGURE 10.28
(a) Original image. (b) Image histogram.
(c) Result of global thresholding with $T$ midway between the maximum and minimum gray levels.
Chapter 10
Image Segmentation

FIGURE 10.29
(a) Original image. (b) Image histogram.
(c) Result of segmentation with the threshold estimated by iteration.
(Original courtesy of the National Institute of Standards and Technology.)
Chapter 10
Image Segmentation

FIGURE 10.30
(a) Original image. (b) Result of global thresholding.
(c) Image subdivided into individual subimages.
(d) Result of adaptive thresholding.
\[ g(x,y) = \begin{cases} 
0 & \text{if } P^*(\nabla f, \text{sobel twice}) < T \\
+ & \text{if } P^*(\nabla f, \text{sobel pair}) \geq T \& \nabla^2 f \geq 0 \\
- & \text{if } P^*(\nabla f, \text{sobel pair}) \geq T \& \nabla^2 f < 0 
\end{cases} \]

Note: + to - and - to + indicate edge transitions.
FIGURE 10.37
(a) Original image. (b) Image segmented by local thresholding. (Courtesy of IBM Corporation.)