Skinline Detection in Digitized Mammograms

Mohamed Abdel-Mottaleb, Charles S. Carman, Charles R. Hill, and Shohreh Vafai

LOCATING THE skin-background boundary is important as the first step of a system to assist radiologists in detecting and assessing breast abnormalities. A global grey value threshold was previously used^{1,2} to segment the image into foreground and background, followed by operations to trace and smooth the boundary between the two regions.

Figure 2 shows the intensity histogram of a typical lateromedial oblique view mammogram, such as the one shown in Figure 1. Three peaks can be identified in the histogram: a background peak (leftmost, darkest), a breast peak, and an artifact peak (rightmost, brightest). Figure 1 shows three boundaries from global thresholding at selected values between the background peak and the breast peak. A low threshold value may connect the nipple region to the edge of the image, whereas a high threshold value may exclude subcutaneous tissue.

Another approach is to use edge detection to find the skinline. A simple edge detector will have

Fig 2. Histogram showing three intensity peaks and thresholding levels.

difficulty segmenting noisy images into breast and background regions. Our method combines the strengths of the thresholding and edge detection methods, resulting in robust localization of the skin-background boundary over a variety of image degradations.

METHOD

Our first step is to locate the interior of the breast. Thresholding is done at a value approximately half way between the background and breast peaks in the intensity histogram. The resulting binary image is processed to find the widest row in the breast and the narrowest rows both above and below the wide row.

The second step is to locate pixels with intensity gradients appropriate to the subcutaneous region of the breast. This is done by computing directional gradients and thresholding to keep only the significant gradient pixels.

The breast region is found via the union of the two mask images produced in the preceding two steps. Figure 3 shows the boundary resulting from the application of this method on the example mammogram shown in Figure 1.

Connections between the breast region and the background are detected by finding horizontal lines of bright pixels that are

Fig 1. Thresholding boundaries drawn over the example mammogram.

From Philips Research, Briarcliff Manor, NY.

Address reprint requests to Mohamed Abdel-Mottaleb, Philips Research, 345 Scarborough Road, Briarcliff Manor, NY 10510.

*Copyright © 1997 by W.B. Saunders Company
0897-1889/97/1003-1073\$3.00/0*

Fig 3. Final mask boundary shown on example mammogram.

much longer than their neighbors. We have investigated several methods for removing these lines, including fitting a second-degree polynomial to the border on either side of these lines.

RESULTS

We have tested the method on more than 500 film images from a variety of clinical sites scanned on a Lumisys scanner and converted to 400-micron spatial resolution and 8 bits/pixel (256 intensity values). Our largest image set consisted of 397 images. An acceptable boundary was located in 389 (98.0%) of the images. In a second set of 281 images, an acceptable boundary was located in 276 images (98.2%).

REFERENCES

1. Fang-Fang Yin et al: Computerized detection of masses in digital mammograms: Analysis of bilateral subtraction images. *Med Phys* 18:955-963, 1991
2. Nishikawa R, et al: Computer-aided detection and diagnosis of masses and clustered microcalcifications from digital mammograms. *SPIE Conference, Med Imag: Image Process* 1905:422-431, 1993