Image Analysis: Part 1: Where Is It Going?

John Keith Beddow, Ph.D

Classical image analysis programs do not imitate the way humans analyze images. By paying close attention to how humans extract information from images, more advanced, more powerful image analysis systems can be designed.

Most current image analysis techniques develop data by counting pixels included in a user-identified line or area. This data analysis technique is some-what limiting in that only rudimentary mathematical processing techniques can be used, primarily addition and subtraction. In contrast, human beings recognize size, shape, roughness, color, texture, and other image features. We process this data artlessly and we are able to describe the viewed objects with a wide variety of verbal descriptors and comparisons. Typically we describe an object's size by comparing it with an object of known size, golf ball-sized hail, for example. Similarly we describe an object's shape by comparing it with a known, familiar shape. We may use such terms as oval, round, rectangular, needle-like, irregular or even lumpy. We even add qualifiers such as very angular, rather spherical and so on. Thus humans have an inherent ability to recognize partial shapes and relative sizes. If similar techniques can be incorporated into advanced image analysis systems, analysis results can be generated that relate more closely to the human experience and at the same time, make possible more powerful mathematical analysis of the image.

Image Analysis

Although humans are very good at analyzing images, the process is very 'labor intensive'. If we can get a machine to do the analysis process for us, we are saved a lot of effort. Also there is a technical need for numerical descriptors for comparing and analyzing images that can be conveniently supplied by image analyzers. Such numerical descriptors add precision to the analysis process, a capability difficult to achieve using verbal terms.

Reviewing Classical Image Analysis

As of 1995, classical image analysis is a 40 year old technology concerned with the measurement of elementary image features. This is usually done by pixel counting. The actual analysis is simple, even primitive. For example, consider the object in Figure 1. Let us use an image analyzer to measure the following characteristics:

- The intercept length
- The perimeter of the object
- The area of the object

We know from simple algebraic geometry that the intercept is the length of the line between X_1Y_1 and X_2Y_2 is the absolute value of:

$$I = \sqrt{((X_1 - X_2)^2 + (Y_1 - Y_2)^2)}$$

Classical image analyzers do not determine the intercept using such equations. Instead they very simply and elegantly count the pixels. By knowing the size of each pixel - let's call it 'f', the line length can be determined by counting the number of pixels in the line and multiply it by the pixel width to determine the line length. Thus the line length is 'nf'. There is no need for algebra or more sophisticated processes, just a simple bit of arithmetic, as in multiplication, does the trick. Determining the perimeter of an object is a similar process. It is determined by counting the number of pixels making up the perimeter and multiplying this number by the pixel width, 'f'. Again, simple arithmetic is all that is required.

In the case of area measurement, once the area of each pixel, 'C', is known, the image analyzer simply counts the pixels within a defined area and multiplies this times the pixel area to produce 'nC', the object's area.

Notice that in each case only simple arithmetic is required to quantify each image feature. Because classical image analyzers only count pixels, is that a drawback? Well, yes and no. If you want a fast and easily produced number for a basic parameter, than pixel counting is certainly a good way to get at it. Certainly this is the way it has been done. However there are a number of desirable image analysis techniques, some requiring the use of such mathematical

Continued on Page 28

Yet Another Method For Making 2 X 2 Projection Slides Directly From EM Negatives

Robert Santoianni, Emory University Hospital

Several excellent techniques for the production of high quality projection electron micrographs have been described in past issues of this newsletter. I am surprised, however, that the following method has not been presented. It was taught to me by Dr. Russell Brynes more than 15 year ago.

Our darkroom is outfitted with a Durst S-45 EM photographic enlarger and AGFA Radioprint processor. The AGFA phototypesetting processor is a four bath stabilization system used for making continuous-tone B&W prints on film or paper. The film of choice for this application is AFGA Copyproof RA711p, a very high contrast orthochromatic film. I cut 8" x 10" sheets into 2" x 8" strips and use a fabricated cardboard guide taped to the enlarger baseboard to position the film during exposure.

Condenser configuration for 3 1/4" x 4" film or plates is 240T (inverted) over 240T with 135 mm lens for adequate reduction to 35 mm. 35 mm negatives are printed by condenser configuration 200T over 130T with 100 mm lens. The point light source must be aligned for optimal exposure after changing configurations. I like to run the voltage low and make a 2 second exposure because the film is hand held in place on the guide. Three exposures will fit on each strip. By replacing the stabilizer component of the processor with fixer, archival quality can be attained. Projection slides produced by this method 15 years ago are still clear and have not deteriorated.

I prefer Kodak Ready Mounts to mount projection slides, however, square-hole mounts for slides made from 35 mm negatives are no longer available from Kodak. Recently, I have gotten them from another manufacturer through a local camera shop.

This method is incredibly fast (dry to dry processing in 1 minute) and gives high quality results. In a high volume, quick turnaround laboratory like ours, it is the simplest and most economical way to go. ■