WHAT ELSE CAN YOU DO WITH RASTEROP?

Affine transforms are the set of linear geometrical transforms on a two-dimensional image that encompass translation, shear, rotation and scaling. Except for scaling, all of these operations can be implemented using rasterop! Translation is obvious: you choose entire image as the source block, and place it, appropriately translated, in the destination. Shear is implemented by translating blocks of image by different amounts. For example, you can imagine a horizontal "clockwise" shear about the center of the image where horizontal full width blocks are shoved to the right above the center and to the left below the center. Blocks near the top and bottom are pushed farther than blocks near the center; the distance a block moves horizontally increases linearly with the vertical distance of the block from the center of the image. Rotation is accomplished by three successive shears, alternating in horizontal and vertical directions; the details are given in the source code. (For small angles, a two-shear approximation to a rotation can be used. Th resulting rotation angle is correct, but the length-to-width ratio is altered by a fraction equal to the square of the angle.

So for a 1 degree rotation angle, the two-shear rotation changes the length-to-width ratio by about 1/3000 -- about 1 pixel for a typical document image.) It should be noted that all these operations can be done *in-place*, by which we mean that the *src* and *dest* are the same image. In such situations when there is translation, care must be taken to clear those parts of the image that are not translated.

Binary morphology is most easily implemented by full-image rasterop. A *dilation* takes a (bit) *union* of various translates of the *src* image, whereas erosion takes a (bit) *intersection* of translates. Dilation and erosion are *dual* operations, in that dilation on the foreground is equivalent to an erosion of the background, and v.v. However, we typically visualize binary images non-symmetrically, with emphasis on the foreground (ON) pixels. Viewed this way, dilation has the effect of smearing out the foreground, whereas erosion thins the foreground and acts as a pattern matching operation for foreground patterns. The pattern that specifies the translations for a dilation or erosion is called a *structuring element*. If we view a morphological operation from the vantage point of each *dest* pixel, we see that the outcome (ON or OFF) depends on a set of pixels in the *src* image whose positions relative to the *dest* pixel are given by the structuring element.

The morphological *opening* and *closing* operations are derived from dilation and erosion: the opening is a sequence of erosion and dilation, using the same structuring element; the closing is a dilation/erosion sequence. Opening and closing have the particularly nice property of *idempotence*, so that repeated opening or dilation has no further effect. This is a filtering property that we we associate with ideal sieves or projection operators, and for this reason image morphology operations are often called morphological *filters*. For a further introduction, go to the section on binary morphology.

Grayscale morphology is a generalization of binary morphology to images with more than one bit/pixel, with dilation and erosion being defined as a *max* and *min*, respectively, of a set of pixels. Binary morphology occupies a central role in document image analysis, because (particularly with multiscale extensions) it is able to extract both shape and texture. For an introduction to these methods, see *Multiresolution morphological approach to document image analysis , published in SPIE Conf. 1818, Boston, Nov. 1992.*

Source: http://www.leptonica.com/rasterops.html