SHEARING AN IMAGE

It is useful to have horizontal shears about an arbitrary horizontal line, and vertical shears about an arbitrary vertical line. For horizontal shears, pixels are moved horizontally by a distance that increases linearly with the (vertical) distance from the horizontal line, moving to the right above the line and to the left below the line for positive angles. Likewise, for vertical shear, pixels are moved vertically by a distance the increases linearly with the (horizontal) distance from the vertical line, moving downward to the right of the line and upward to the left of the line for positive angles.

Formally, a horizontal shear of angle *theta* about a line y = b, with the origin at the UL corner and a cw rotation taken to be positive, is

$$[x'\ y'] = [x\ \ y\ \ 1]T \qquad (13)$$

where T is the 3x2 matrix:

$$T = \begin{bmatrix} 1 & 0 \\ -\tan(\text{theta}) & 1 \\ b*\tan(\text{theta}) & 0 \end{bmatrix} \qquad (14)$$

Likewise, a vertical shear of angle *theta* about a line x = a is given by (13) with

T = [1 -tan(theta)

0 1 (15)

0 a*tan(theta)]

All interfaces to implementations of shear in ***Leptonica*** are given at a high level, using the PIX data structure. Two-image shear, where the src is unchanged, is implemented by *pixRasterop()*. For example, a horizontal shear requires moving full-width blocks of pixels horizontally by varying amounts, depending on the vertical location of the block. The height of the block is inversely proportional to the shear angle, appropriately integerized. We express angles in radians, which are a natural unit, because for small angles the height of each block is approximately equal to the inverse of the shear angle.

We provide special cases where the image is sheared about the upper-left corner and also about the center. When shearing by very small angles, the block height (for horizontal shear) is large. When shearing about the upper-left corner, the height of the block that is not moved is only half the block height, whereas when shearing about the center of the image, the "dead zone" is the full block height.

We also provide in-place versions of shear, implemented by block shearing of the in-place rasterop functions *pixRasteropHip()* and *pixRasteropVip()*. The higher level two-image horizontal and vertical shear functions *pixHShear()* and *pixVShear()* call the in-place shear functions *pixHShearIP()* and *pixVShearIP()* when the src and dest images are the same.

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