ECE 597IP/697IP Fall 2017 - Image Processing
Homework #1, due in 7 days

Exercise 1. Provide single, composite transformation functions for performing the following operations

(a) Scaling and translation

(b) Vertical shear, scaling, translation and rotation.

(c) Does the order of multiplication of the individuals matrices to produce a single transformation make a difference? Give an example based on a scaling/translation to support your answer.

Exercise 2. We know that an affine transformation of coordinates is given by

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = A \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

where (x', y') are the transformed coordinates and (x, y) the original coordinates. We want to find the inverse transformation A^{-1} to go from the transformed back to the original coordinates.

(a) Find the inverse scaling transformation.

(b) Find the inverse translation transformation.

(c) Find the inverse vertical and horizontal shear transformations.

(d) Find the inverse rotation transformation.

(e) Show a composite inverse translation/rotation transformation (rotation first).

Exercise 3. MATLAB assignment: affine transformations. When interpolation is needed use nearest-neighbor interpolation.

(a) Write a function `g=imageTranslate(f,tx,ty)` for performing image translation, where `f` is a grayscale image and `tx` and `ty` are translation factors (they can be real any real number) in the x (vertical) and y (horizontal) directions. The output image should be of the same size as the input. Test your function by translating image `girl.tif` by half its height in the positive vertical direction and by one fourth of its width in the positive horizontal direction.

(b) Write a function `g= imageRotate(f,theta,mode)` for performing Image rotation (about the image center), where theta is the rotation angle in degrees (the default is zero degrees). A positive angle should produce counterclockwise rotation. If `mode='crop'`, the rotated image should be cropped (about its center) to the same size as the input image. This should be the default. If `mode ='full'`, the output image should be the smallest size capable of containing the full rotated input image for any angle. The background of the rotated image should be black. To test your function, rotate the image `girl.tif` by 45° using both the `'full'` and the `'crop'` modes. Display the results. (Hint: Keep in mind that the rotation equations we saw in class are about the center of the coordinate system, not about the image center. Also, use the inverse transformation)

(c) Apply the inverse rotation `h` with `mode='crop'` to `g` obtained with `mode='full'`. Why does the image have a frame of zeros around it? Remove such frame and display the difference `f-h`. Explain the meaning of bright and dark pixels in the difference image.

Exercise 4. Problems from the textbook DIP 4th edition: 3.9, 3.14.