National Tsing Hua University
Department of Electrical Engineering
EE3662 Digital Signal Processing Laboratory, Fall 2021

Lab 5 Pixel Array Manipulation

Assigned on Nov 1, 2021
Due by Nov 8, 2021

Overview

The goal of this homework is to help you get familiar with pixel array manipulation in MATLAB. First, you will learn how to input/output image file in MATLAB, and then you will need to write some functions to manipulate pixel array, i.e., grayscale, image flipping, image rotation, and image resize in this lab.

Tutorials

1. Each image includes three channels R, G, B, and the size of each channel is height*width.
2. Use imread() / imshow() / imwrite() function to read / show / save the image.
   I = imread(filename), I is a 3 dimension matrix,
   R = I(:, :, 1), G = I(:, :, 2), B = I(:, :, 3).
   Tips: I(1:50, :, 1) =>>> 1:50 = 1~50, ":" = all = 1~width.
3. "a = 3" vs "a = 3;" =>>> it will show the result on command window without ";".
4. Press "ctrl+Enter" to run code between "%%".
5. Press "ctrl+c" to stop running.

Details

1. Grayscale (10%)

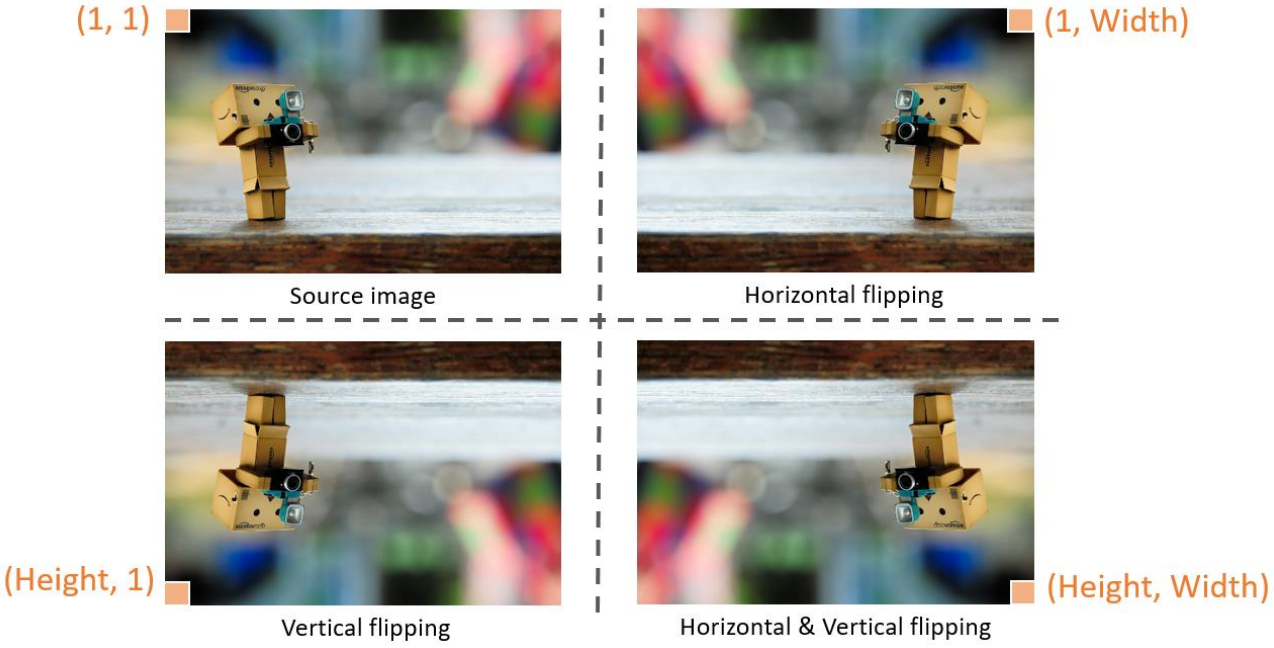
$$Y = [0.299 \quad 0.587 \quad 0.114] * \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Source image | Grayscale

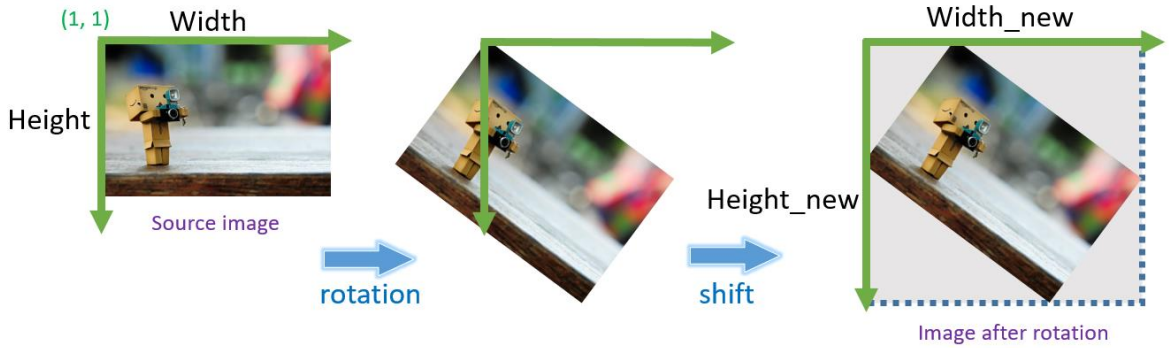
Do not use rgb2gray() function

2. Image flipping (10%)

Implement three kinds of flipping.



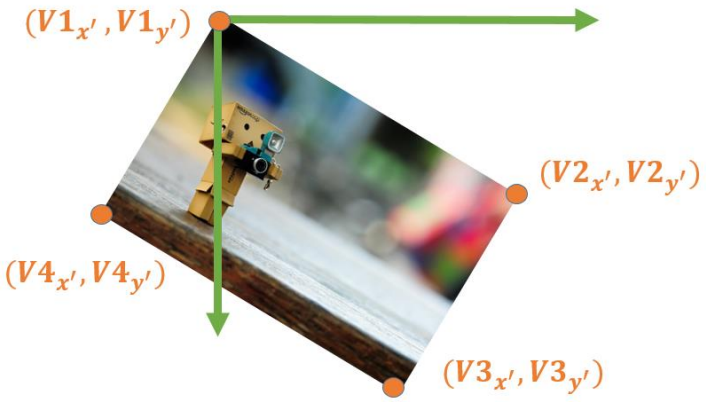
3. Image rotation (15%)



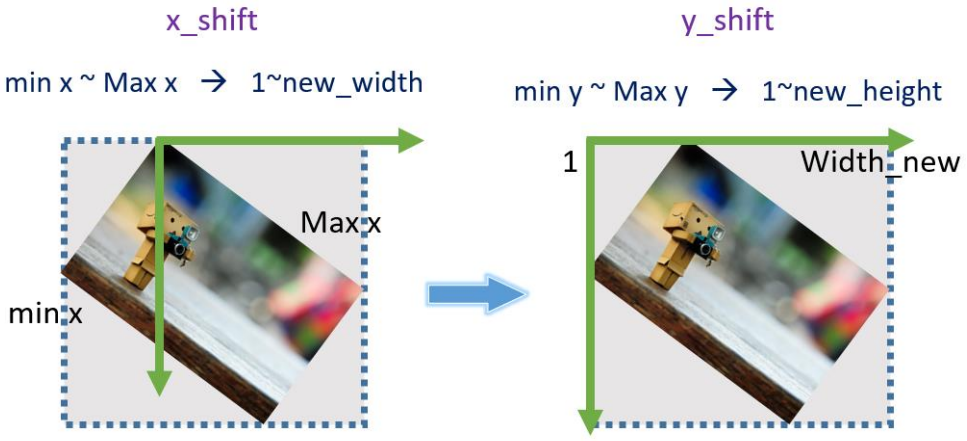
$$Rotation\ Matrix: \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

(1) Record vertices.

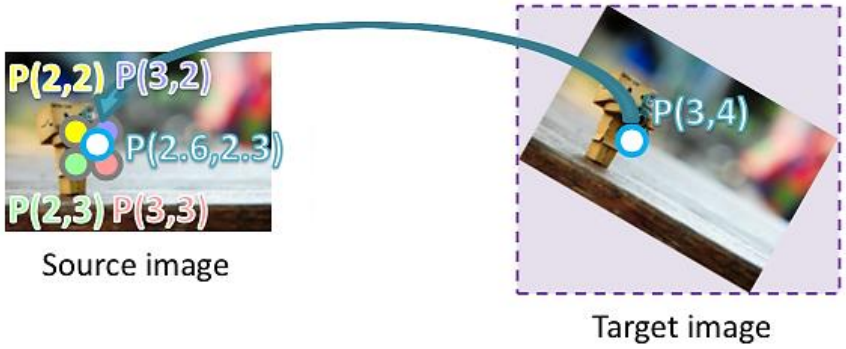
(2) Use rotation matrix to get rotated vertices.



(3) Get new height and width to create new image with zero matrix.

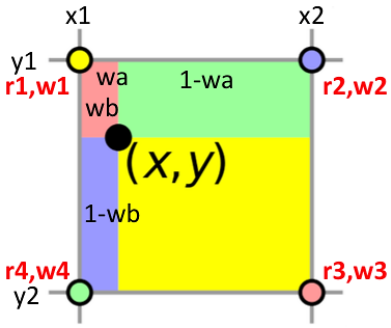


(4) Backward warping.



(5) Bilinear interpolation.

$$
\begin{aligned}
\mathrm{wa} &= (\mathrm{x} - \mathrm{x1}) \,/\, (\mathrm{x2} - \mathrm{x1}) \\
\mathrm{wb} &= (\mathrm{y} - \mathrm{y1}) \,/\, (\mathrm{y2} - \mathrm{y1}) \\
\mathrm{w1} &= (1 - \mathrm{wa}) * (1 - \mathrm{wb}) \\
\mathrm{w2} &= \mathrm{wa} * (1 - \mathrm{wb}) \\
w3 &= wa * wb \\
\mathrm{w4} &= (1 - \mathrm{wa}) * \mathrm{wb}
\end{aligned}
$$

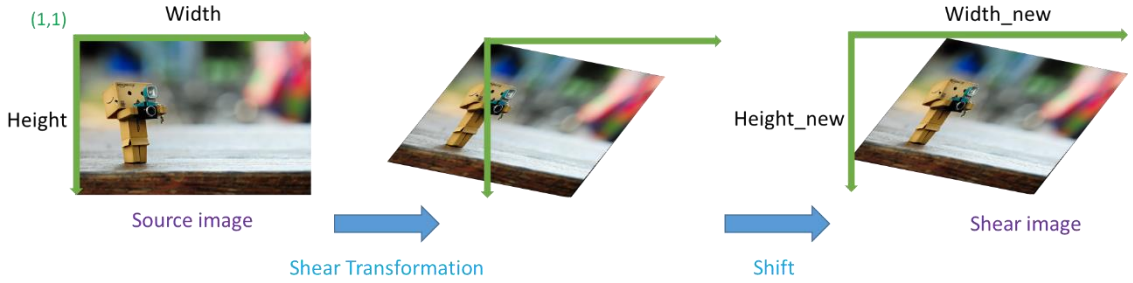


$$
\begin{aligned}
\mathrm{r(x,y)} &= \mathrm{r1} * \mathrm{w1} + \mathrm{r2} * \mathrm{w2} + \mathrm{r3} * \mathrm{w3} + \mathrm{r4} * \mathrm{w4} \\
\mathrm{g(x,y)} &= \mathrm{g1} * \mathrm{w1} + \mathrm{g2} * \mathrm{w2} + \mathrm{g3} * \mathrm{w3} + \mathrm{g4} * \mathrm{w4} \\
\mathrm{b(x,y)} &= \mathrm{b1} * \mathrm{w1} + \mathrm{b2} * \mathrm{w2} + \mathrm{b3} * \mathrm{w3} + \mathrm{b4} * \mathrm{w4}
\end{aligned}
$$

(6) Result image.

Do not use imrotate() function.

4. Shear Transformation (15%)



$$Shear\ Transformation: \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & shear\_x \\ shear\_y & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

(1) Record vertices.
(2) Use transformation matrix to get new vertices.
(3) Get new height and width to create new image with zero matrix.
(4) Backward warping.
(5) Bilinear interpolation.
(6) Result image.

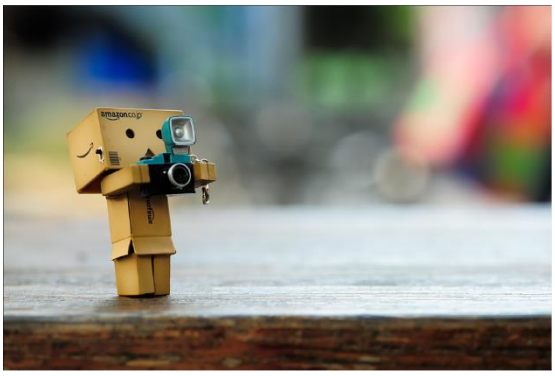
Do not use imwarp() function.

5. Image scaling (10%)

Use the similar interpolation scheme as image rotation to conduct image resize function.

Input image

0.6X



1.5X

Do not use imresize() function.

Report

1. (7%) Show the results in each part with two images. One is given by TA and the other is your own image.

2. (10%) There are two ways for image warping. One is forward warping and the other is backward warping. What are the differences between them? Try to describe the differences subjectively and objectively.

3. (10%) Try to use the forward warping method mentioned above to implement image rotation. Specify the flow of your implementation and show your results. Please include your code in “LAB5/code/”.

4. (10%) Try to implement at least one other method for grey scale, image flipping, image rotation, or image resize. Specify your method and show the results. Compare the differences between the original method in this lab and your proposed method. Please include your code in “LAB5/code/”.

5. (3%) Conclusion.

Deliverable and file organization

Directory	Filename	Description
LAB5/code/	*.m	All MATLAB codes
LAB5/data/	*.png / *.jpg	Your own source image
LAB5/report/	report.pdf	Your report
LAB5/results/	*.png / *.jpg	Your results

Please organize your files according to the above table and compress it as LAB5_10xxxxxxx.zip in ZIP format. (P.S. 10xxxxxxx is your student ID)