Lab-1-Report

Geometric Transforms

COURSE CODE: EE5175 (ISP)

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The following codes are executed and explained in google collab notebook (python) and link is https://colab.research.google.com/drive/1kzXKh5r6b7D1Jpqs50fWIaZOWjBahycs?usp=sharing

- **OpenCV** is a huge open-source library for computer vision, machine learning, and image processing.
- OpenCV library will allow to perform operations on Images. In our codes, we used opencv to read and display images.

Q1. Translate the given image (lena translate.png) by (tx = 3.75, ty = 4.3) pixels.

- Given Translation Parameters are: tx = 3.75, ty = 4.3
- Let (xs,ys) and (xt,yt) be source image co-ordinates and target image co-ordinates respectively.
- We have xt=xs+tx and yt=ys+ty translation.

Bilinear Interpolation:

Bilinear Interpolation considers four nearest neighbours in the source image and does distance weighted average to get a new pixel intensity value for target co-ordinates. The intensity of the four neighbours is weighted and averaged to the intensity value and is assigned to the target.

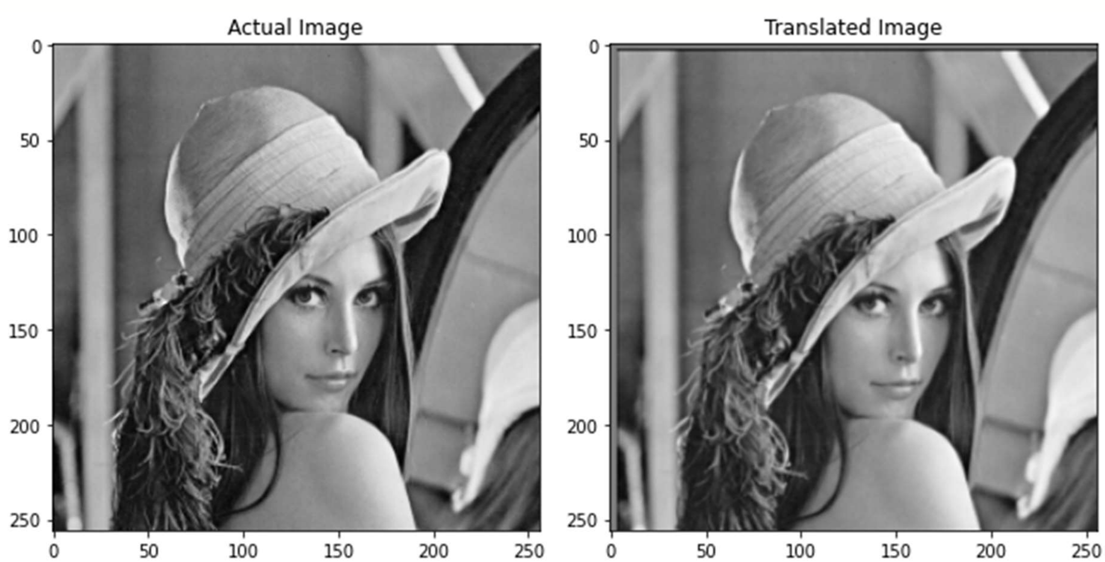
- img_padded: The zero rows and columns are padded at the beginning and ending because for the first and last rows in performing bilinear transformation there should be intensity values for 4 nearest neighbours.
- The number of rows padded depends on n nearest neighbours interpolation.
- Here we chose bilinear transformation so number of nearest neighbours are 4.

Python Code:

```
from numpy import *
import sys
import math
import cv2
import matplotlib.pyplot as plt

img1= cv2.imread("lena_translate.png",0)#imread reads the images
img2= cv2.imread("pisa_rotate.png",0)
img3= cv2.imread("cells_scale.png",0)

tx=3.75
ty=4.3
width, height= img1.shape
print(width, height)
img1_t=zeros((width, height))
img_padded = zeros((width+2, height+2))
img_padded[1:-1, 1:-1] = img1
```

```
for xt in range(width):
  for yt in range(height):
    xs=xt-tx
    ys=yt-ty
    #intensity=img1[xs,ys]
    x=xs+1
    y=ys+1
    xs1=math.floor(x)
    ys1=math.floor(y)
    a=x-xs1
    b=y-ys1
    if xs1>=0 and xs1<=width and ys1>=0 and ys1<=height:
      img1_t[xt,yt]=(1-a)*(1-b)*img_padded[xs1,ys1]+(1-
a)*b*img_padded[xs1,ys1+1]+a*(1-
b)*img_padded[xs1+1,ys1]+a*b*img_padded[xs1+1,ys1+1]
    else:
      img1_t[xt,yt]=125


fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(9,12), constrained_layout=True)
ax1.imshow(img1,'gray')
ax1.title.set_text("Actual Image")
ax2.imshow(img1_t,'gray')
ax2.title.set_text("Translated Image")
```

Result:



Conclusion:

- We can observe grey borders at the edge of image because intensity value 125 is assigned to the values where (xs,ys) doesn't exist.

- We can see that translated image is not clear compared to actual image because of averaging of intensity values in bilinear interpolation.
- Thus the Lena image(img1) is translated by tx=3.75 and ty=4.3.

Q2. Rotate the given image (pisa rotate.png) about the image centre, so as to straighten the Pisa tower.

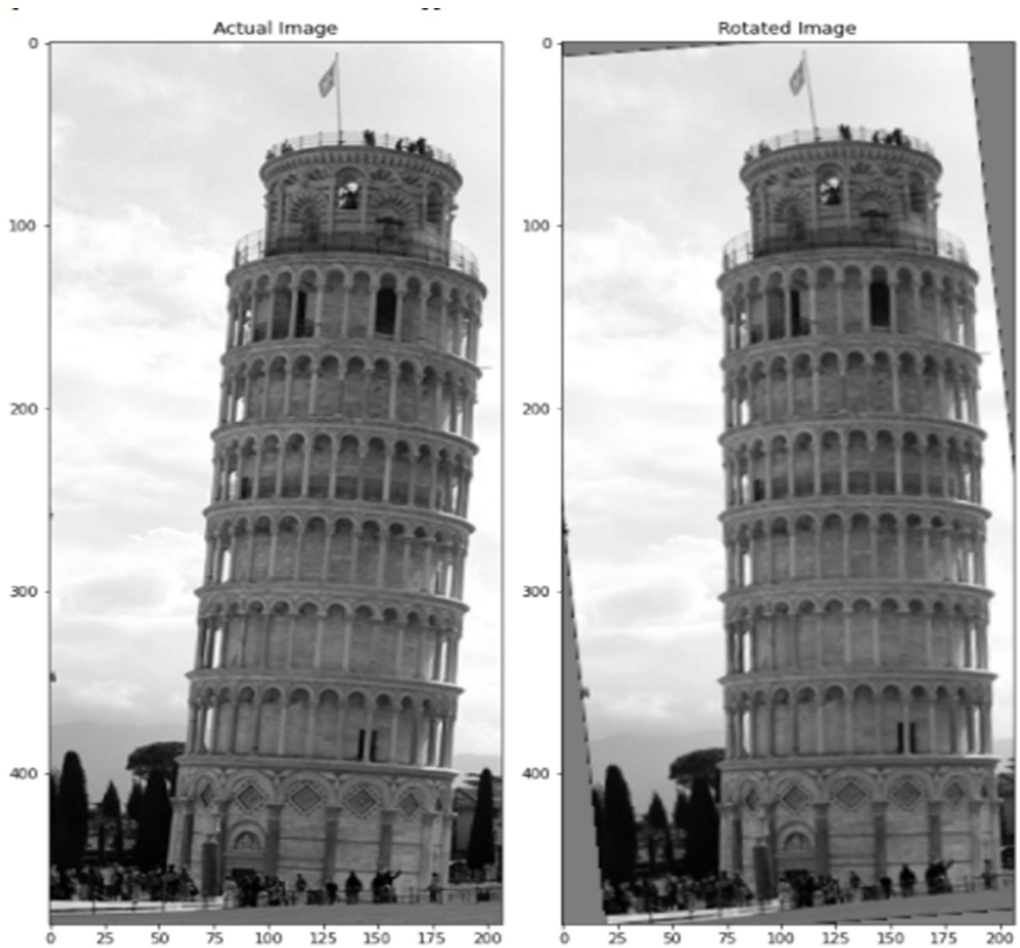
- Given parameters are: θ , by trail and error lets check for its value.
- Let (xs,ys) and (xt,yt) be source image co-ordinates and target image co-ordinates respectively.
- We have xt $= \cos\theta\,.xs + \sin\theta.ys$ and yt $= \cos\theta\,.ys - \sin\theta.xs$ rotation.
- We have to rotate the image about the image center (width2/2, height2/2).
- To rotate around a point, we have to translate to that point and then apply rotation and then translate back

Python Code:

```
#let theta=10',5',4'
theta=-5
theta_r=pi*theta/180
width2, height2= img2.shape
print(width2, height2)

img_padded2 = zeros((width2+2, height2+2))
img_padded2[1:-1, 1:-1] = img2
img2_r=zeros((width2, height2))

for xt in range(width2):
  for yt in range(height2):
      xc, yc = xt-width2/2, yt-height2/2
      xs = cos(theta_r)*xc - sin(theta_r)*yc + width2/2
      ys = cos(theta_r)*yc + sin(theta_r)*xc + height2/2
      x=xs+1
      y=ys+1
      xs1=math.floor(x)
      ys1=math.floor(y)
      a=x-xs1
      b=y-ys1
      if xs1>=0 and xs1<=width2 and ys1>=0 and ys1<=height2:
        img2_r[xt,yt]=(1-a)*(1-b)*img_padded2[xs1,ys1]+(1-
a)*b*img_padded2[xs1,ys1+1]+a*(1-
b)*img_padded2[xs1+1,ys1]+a*b*img_padded2[xs1+1,ys1+1]
      else:
        img2_r[xt,yt]=125

fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(9,12), constrained_layout=True)
```

```
ax1.imshow(img2,'gray')
ax1.title.set_text("Actual Image")

ax2.imshow(img2_r,'gray')
ax1.title.set_text("Rotated Image")
```

Result:



Conclusion:

- By the trail and error values for rotation angle(θ) we can see straight tower at an angle of -5'.
- For the clock wise rotation, the angle should be positive as pisa tower has to be rotated counter clk-wise, the angle supplied is negative.
- The Pisa tower image is rotated in anti-clock wise direction by θ = -5 degrees.

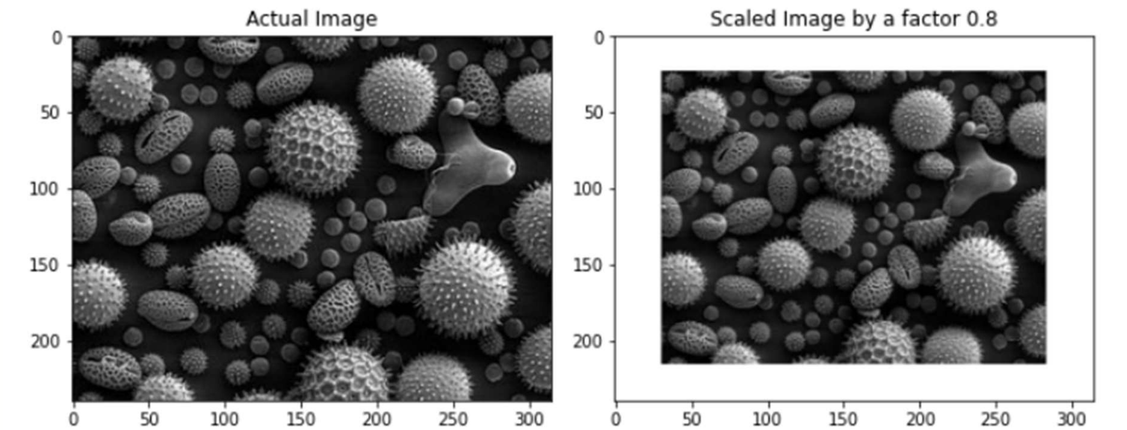
Q3. Scale the given image (cells scale.png) by 0.8 and 1.3 factors.

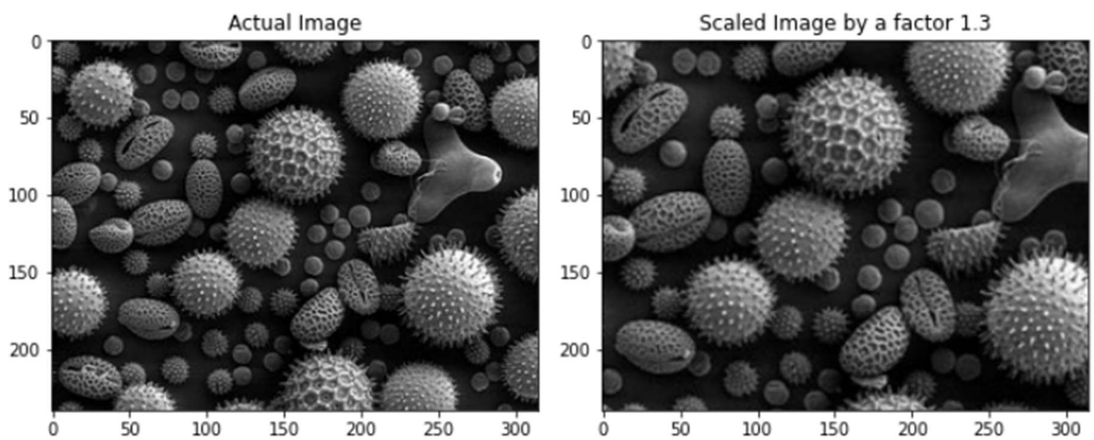
- Given scaling parameters are: $a = 0.8$, $a = 1.3$.

- Let (xs,ys) and (xt,yt) be source image co-ordinates and target image co-ordinates respectively.
- We have $xt = a * xs$ and $yt = a * ys$ scaling.
- We have to scale the image about the image center (width2/2, height2/2).
- To scale around a point, we have to translate to that point and then apply scaling and then translate back.

Python Code:

```
a1=0.8
#a=1.3
width3, height3= img3.shape
print(width3, height3)

img_padded3 = zeros((width3+2, height3+2))
img_padded3[1:-1, 1:-1] = img3
img3_s=zeros((width3, height3))


xc=width3/2
yc=height3/2
for xs in range(width3):
  for ys in range(height3):
    xt = (xs-xc)/a1 + xc
    yt = (ys-yc)/a1+yc
    x=xt+1
    y=yt+1
    xs1=math.floor(x)
    ys1=math.floor(y)
    a=x-xs1
    b=y-ys1
    if xs1>=0 and xs1<=width3 and ys1>=0 and ys1<=height3:
      img3_s[xt,yt]=(1-a)*(1-b)*img_padded3[xs1,ys1]+(1-
a)*b*img_padded3[xs1,ys1+1]+a*(1-
b)*img_padded3[xs1+1,ys1]+a*b*img_padded3[xs1+1,ys1+1]
    else:
      img3_s[xt,yt]=0


fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(9,12), constrained_layout=True)
ax1.imshow(img3,'gray')
ax1.title.set_text("Actual Image")
ax2.imshow(img3_s,'gray')
ax2.title.set_text("Scaled Image by a factor 0.8")
```





Conclusion:

- From the result, we can infer that a=0.8 implies zoom out operation and a=1.3 implies zoom in operation.
- In scaling operation there will be translation along z axis(optical axis).
- we have a=(1+tx/d) for the zoom in operation d decreases and as a result we have a>1 and for the zoom out operation d increases and a<1.
- Therefore we applied uniform scaling on the cells image with scaling factors 0.8,1.3.