Project #4

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- Source codes

```
# library
import numpy as np
import cv2
from matplotlib import pyplot as plt
import math
from google.colab.patches import cv2_imshow
%matplotlib inline

# load picture from google drive
from google.colab import drive
drive.mount('/content/drive')

# loaded the image in grayscale
image = cv2.imread('/content/drive/MyDrive/Bird 3 blurred.tif')

# show origin image
cv2_imshow(image)

# get rgb channel
B = image[:,:,0]
G = image[:,:,1]
R = image[:,:,2]

# show R channel
cv2_imshow(R)

# show G channel
cv2_imshow(G)

# show B channel
cv2_imshow(B)
```

```python
# rgb to hsi
def rgb2hsi(img):
    row, col = img.shape[:2]
    H = np.zeros((row,col))
    S = np.zeros((row,col))

    B,G,R = cv2.split(img)
    B,G,R = B / 255.0 , G / 255.0, R / 255.0

    I = (R+G+B)/3.0

    for i in range(row):
        for j in range(col):
            min_value = np.min([R[i][j],B[i][j],G[i][j]])
            sum = R[i][j]+G[i][j]+B[i][j]

            if sum == 0:
                S[i][j] = 0
            else:
                S[i][j] = 1 - (3* min_value / sum)

            den = ((R[i][j]-G[i][j])**2+(R[i][j]-B[i][j])*(G[i][j]-B[i][j]))**0.5
            if den == 0:
                thetha = 1
            else:
                thetha = (0.5 * (2*R[i][j]-G[i][j]-B[i][j])) / den
            thetha = np.clip(thetha,-1,1)
            thetha = np.arccos(thetha) / (2*math.pi)

            if B[i][j] <= G[i][j]:
                H[i][j] = thetha
            else:
                H[i][j] = 1 - thetha
```

```python
# convert rgb to hsi
H,S,I = rgb2hsi(image)

# show H channel
cv2_imshow(H * 255)

# show S channel
cv2_imshow(S * 255)

# show I channel
cv2_imshow(I * 255)
```

```python
# hsi to rgb
def hsi2rgb(H,S,I):
    row, col = H.shape
    R = np.zeros((row,col))
    G = np.zeros((row,col))
    B = np.zeros((row,col))

    H = H * np.pi * 2
    rad_60 = 60 / 180 * np.pi
    for i in range(row):
        for j in range(col):

            if(H[i][j] < 2 * np.pi / 3):
                B[i][j] = I[i][j] * (1 - S[i][j])
                R[i][j] = I[i][j] * (1+ (S[i][j]*np.cos(H[i][j])/np.cos(rad_60-H[i][j])))
                G[i][j] = 3 * I[i][j] - (R[i][j] + B[i][j])
            elif(H[i][j] < 4 * np.pi / 3):
                H_GB = H[i][j] - 2 * rad_60
                R[i][j] = I[i][j] * (1 - S[i][j])
                G[i][j] = I[i][j] * (1+ (S[i][j]*np.cos(H_GB)/np.cos(rad_60-H_GB)))
                B[i][j] = 3 * I[i][j] - (R[i][j] + G[i][j])
            else:
                H_RB = H[i][j] - 4 * rad_60
                G[i][j] = I[i][j] * (1 - S[i][j])
                B[i][j] = I[i][j] * (1+ (S[i][j]*np.cos(H_RB)/np.cos(rad_60-H_RB)))
                R[i][j] = 3 * I[i][j] - (B[i][j] + G[i][j])

    return R,G,B
```

```
# laplacian kernel
laplacian_kernel = np.zeros((3,3))
laplacian_kernel[0] = [-1,-1,-1]
laplacian_kernel[1] = [-1,9,-1]
laplacian_kernel[2] = [-1,-1,-1]

# sharp rgb image
sharp_rgb = cv2.filter2D(image,-1,laplacian_kernel)

# show sharpened rgb image
cv2_imshow(sharp_rgb)

# sharp hsi image
sharp_i = cv2.filter2D(I,-1,laplacian_kernel)

# convert sharpened hsi to rgb
r,g,b = hsi2rgb(H,S,sharp_i)

# show sharpened hsi-based image
sharp_hsi = np.stack((b*255,g*255,r*255),axis=2)
cv2_imshow(sharp_hsi)

# show different between hsi-based and rgb-based
cv2_imshow(sharp_hsi-sharp_rgb)
```

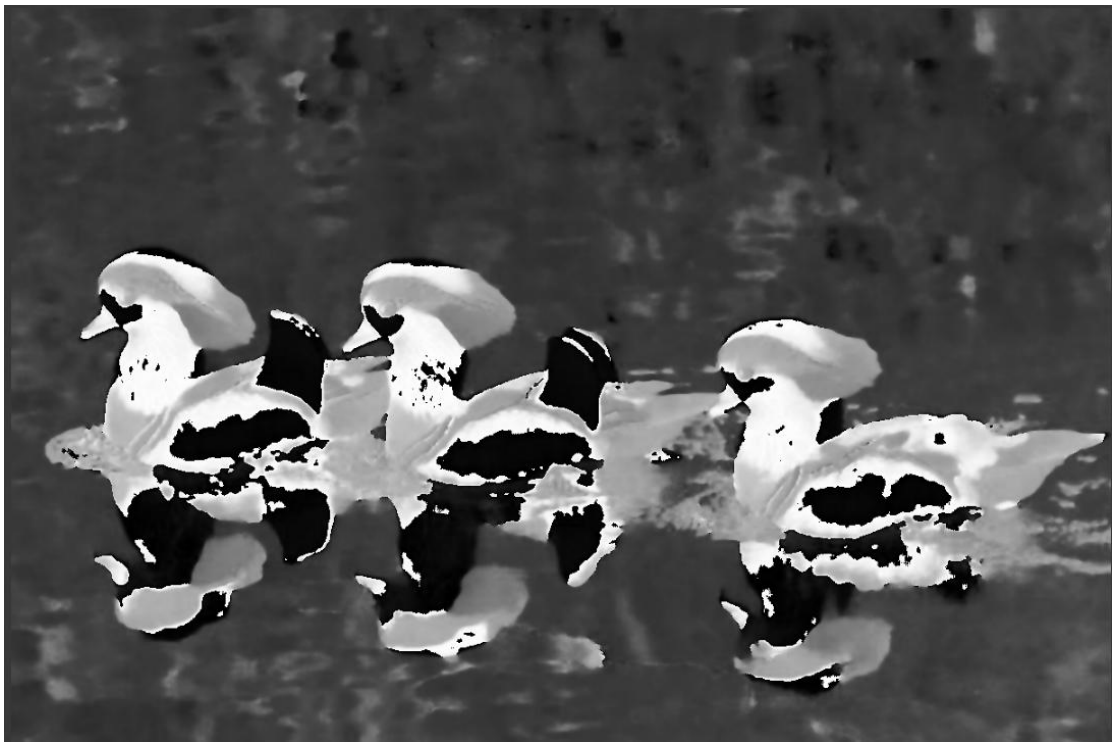
- Figures of R, G, B, H, S and I component images

  R channel

G channel

B channel

H channel



S channel

I channel

- Figures of RGB-based and HSI-based sharpened images and their difference image.
  RGB-based

HSI-based

difference image