RYERSON UNIVERSITY

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| Course Title: | Digital Image Processing |
| Course Number: | ELE 882 |
| Semester/Year | Fall/2019 |

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| Instructor: | Ling Guan |

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| Assignment/Lab Number: | 1 |
| Assignment/Lab Title: | Assignment 1 |

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| Submission Date: | October 1, 2019 |
| Due Date: | October 1, 2019 |

| Student LAST Name | Student FIRST Name | Student Number | Section | Signature* |
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**Introduction**

This lab introduced various methods of image processing. Different transforms will be applied to images and the effects will be examined.

**Analysis**

**Question 1**

To do an alpha mask you can let intensity

I(x,y) = (Ia(x,y) + Ib(x,y)*Normalize(M(x,y)))/2

- Where Ia is the intensity of image a

- Where Ib is the intensity of image b

- Where M is the intensity of the mask

This is taking the average of the two images intensities taking the mask into account

**Question 2**

- T(r) applies a contrast$_stretchwhichnormalizesthecontrastintheimage.Inotherwordsevenlydistributingthein$

**Question 3**

- LUT can also improve performance for computation intensive transforms.

- The LUT takes alot of memory which can be bad if running on a small machine.

- The LUT harder to modify than a function pointer.

- In the case of contrast stretching it depends on the image making it non reusable.

- LUT's can't be reused for translation transforms

**Question 4**

- Contrast stretching could be used to bring the higher intensity range down to the display range by normalizing all the values then multiplying them by 2^8.

- Ie 2^8*(r/(r$_max - r_min) - r_min/(r_max - r_min)$

- Some considerations should be made if there is large amounts of intensities in a small range as the detail will be lost on the display.

**Question 5**

- If an image is very dim then the range of intensities would be low making the contrast stretching hard to impossible. As many distinct points would share intensities, they would be normalized to the same value.

- Sensor noise on a dim image will have the effect of disabling or significantly hindering the contrast stretch. This is due to the noise widening the range between r$_min and r_max.With the upper bound having noise from 0 to 255 totally disabling the contrast stretch.$

**Conclusion**

Throughout the lab, various forms of image processing were used and analyzed.

**Section 2.1 - Q1**

infile = "Images/Section2.1 - Q1/207056.jpg"

img = Image.open(infile)

img.load()

problem1 = np.asarray(img, dtype="int32")

def apply$_p oint_t frm(data, C, B)$ :

out = copy.deepcopy(data)

for y in range(0, len(data)):

for x in range(0, len(data[y])):

out[y][x] = C * out[y][x] + B

return out

transform = apply$_p oint_t frm(problem1, 4, -10)$

Image.fromarray(transform).show()

**Section 2.1 - Q2**

infile = "Images/Section2.1 - Q2/fish.png"

infile2 = "Images/Section2.1 - Q2/bridge.png"

maskfile = "Images/Section2.1 - Q2/mask.png"

img = Image.open(infile)

img.load()

$\text{img}_data = np.asarray(img, dtype = \text{"}int32\text{"})$

img2 = Image.open(infile2)

img2.load()

img2data = np.asarray(img2, dtype="int32")

mask = Image.open(maskfile)

mask.load()

$\text{mask}_data = np.asarray(mask, dtype = \text{"}int32\text{"})$

def $\text{apply}_mask(imga, imgb, imgmask)$ :

out = copy.deepcopy(imgb)

for y in range(0, len(imgmask)):

for x in range(0, len(imgmask[y])):

if imgmask[y][x] > 0:

out[y][x] = imga[y][x]

return out

transform = applymask(imgdata, img2data, maskdata)

Image.fromarray(transform).show()

**Section 2.1 - Q3**

infile = "Images/Section2.1 - Q3/snowglobe$_0$01.$png$"

infile2 = "Images/Section2.1 - Q3/snowglobe$_0$02.$png$"

infile3 = "Images/Section2.1 - Q3/snowglobe$_0$03.$png$"

infile4 = "Images/Section2.1 - Q3/snowglobe$_0$04.$png$"

def average$_i mages(*args)$ :

img = Image.open(args[0])

img.load()

out$_d ata = np.asarray(img, dtype = "int32")$

for image in args[1:]:

img = Image.open(image)

img.load()

img$_d ata = np.asarray(img, dtype = "int32")$

for y in range(0, len(img$_d ata$)) :

for x in range(0, len(img$_d ata[y]$)) :

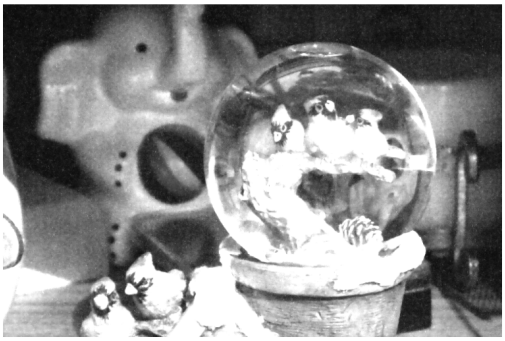
out$_d ata[y][x] += img_d ata[y][x]$

return out$_d ata$

return np.vectorize(lambda x: x / len(args))(out$_d ata$)

transform = average$_i mages(infile, infile2, infile3, infile4)$

Image.fromarray(transform).show()



**Section 2.2 - Q1**

infile = "Images/Section2.2 - Q1/motion01.512.tiff"

img = Image.open(infile)

img.load()

$\text{img}_data = np.asarray(img, dtype = "int32")$

def $\text{contrast}_stretch(img_data)$ :

$\text{out}_data = copy.deepcopy(img_data)$

$\text{sorted}_= np.sort(out_data.flatten())$

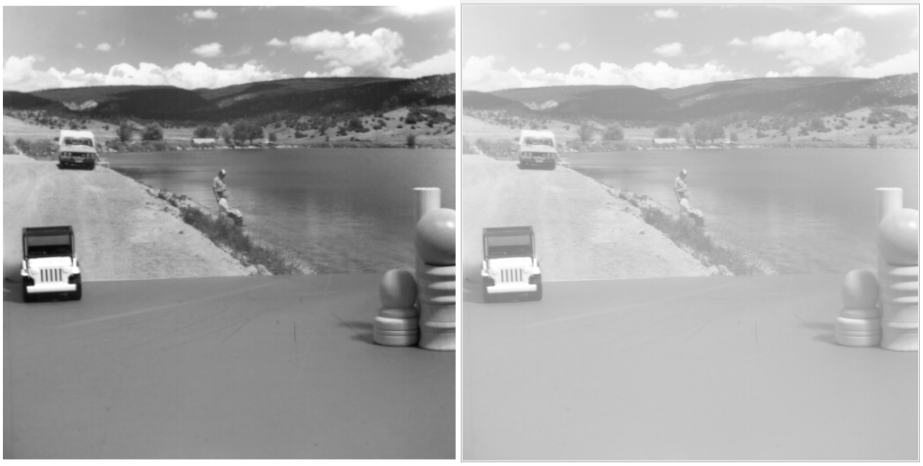
$\max_= float(sorted_[-1])$

$\min_= float(sorted_[0])$

return np.vectorize(lambda x: $255 * (\text{float(x)} / (\max\_min_) - min_/(max\_min_)))(out_data).astype("int32")$

transform = $\text{contrast}_stretch(img_data)$

Image.fromarray(transform).show()



**Section 2.2 - Q2**

infile = "Images/Section2.2 - Q2/7.1.01.tiff"

img = Image.open(infile)

img.load()

$\text{img}_data = np.asarray(img, dtype = "int32")$

$\text{def contrast}_piecewise(img_data, vec_a, vec_b)$ :

$\text{out}_data = copy.deepcopy(img_data)$

x1, y1 = $\text{vec}_a$

x2, y2 = $\text{vec}_b$

func1 = lambda x: x * x1 / y1

func2 = lambda x: x * (y2 - y1) / (x2 - x1)

func3 = lambda x: x * (255 - y2) / (255 - x2)

$\text{def apply}_funcs(brightness)$ :

if brightness $<$ x1:

return func1(brightness)

elif brightness $>$ x2:

return func3(brightness)

else:

return func2(brightness)

$\text{return np.vectorize(apply}_funcs)(out_data).astype("int32")$

$\text{transform} = \text{contrast}_piecewise(img_data, (20, 10), (200, 150))$

**Section 2.2 - Q3**

infile = "Images/Section2.2 - Q3/3096.jpg"

img = Image.open(infile)

img.load()

$\text{img}_data = np.asarray(img, dtype = "int32")$

def $\text{contrast}_highlight(img_data, A, B, I_min)$ :

$\text{out}_data = copy.deepcopy(img_data)$

return np.vectorize(lambda x: $\text{I}_m inif x < Aorx > Belsex)(out_data).astype("int32")$

transform = $\text{contrast}_highlight(img_data, 50, 200, 255)$

Image.fromarray(transform).show()

**Section 2.2 - Q4**

def apply$_lut(img_data, lut)$ :

return np.vectorize(lambda x: lut[x])(img$_data$)

**Section 2.2 - Q5**

def gen$_n on_g eneric_l ut(func, img_data, *args)$ :

after = func(img$_data, *args)$

out =

for y in range(0, len(img$_data$)) :

for x in range(0, len(img$_data[y]$)) :

out[img$_data[y][x]] = after[y][x]$

return out

infile = "Images/Section2.2 - Q1/motion01.512.tiff"

img = Image.open(infile)

img.load()

img$_data = np.asarray(img, dtype =$ "$int32$")

Q1$_L UT = gen_n on_g eneric_l ut(contrast_s tretch, img_data)$

transform = apply$_lut(img_data, Q1_L UT)$

Image.fromarray(transform).show()

**Section 2.2 - Q6**

def gen$_lut(func, *args)$ :

orig = np.fromiter(range(0, 256), "int32")

after = func(orig, *args)

out =

for i in range(0, 256):

out[i] = after[i]

return out

Q2

infile = "Images/Section2.2 - Q2/7.1.01.tiff"

img = Image.open(infile)

img.load()

img$_data = np.asarray(img, dtype =$ "$int32$")

Q2$_LUT = gen_lut(contrast_piecewise, (20, 10), (200, 150))$

print(Q2$_LUT$)

transform = apply$_lut(img_data, Q2_LUT)$

Image.fromarray(transform).show()

Q3

infile = "Images/Section2.2 - Q3/208001.jpg"

img = Image.open(infile)

img.load()

img$_data = np.asarray(img, dtype =$ "$int32$")

Q3$_LUT = gen_lut(contrast_highlight, 50, 200, 255)$

transform = apply$_lut(img_data, Q3_LUT)$

Image.fromarray(transform).show()