Digital Image Processing

IMP 301

Progress Test 3

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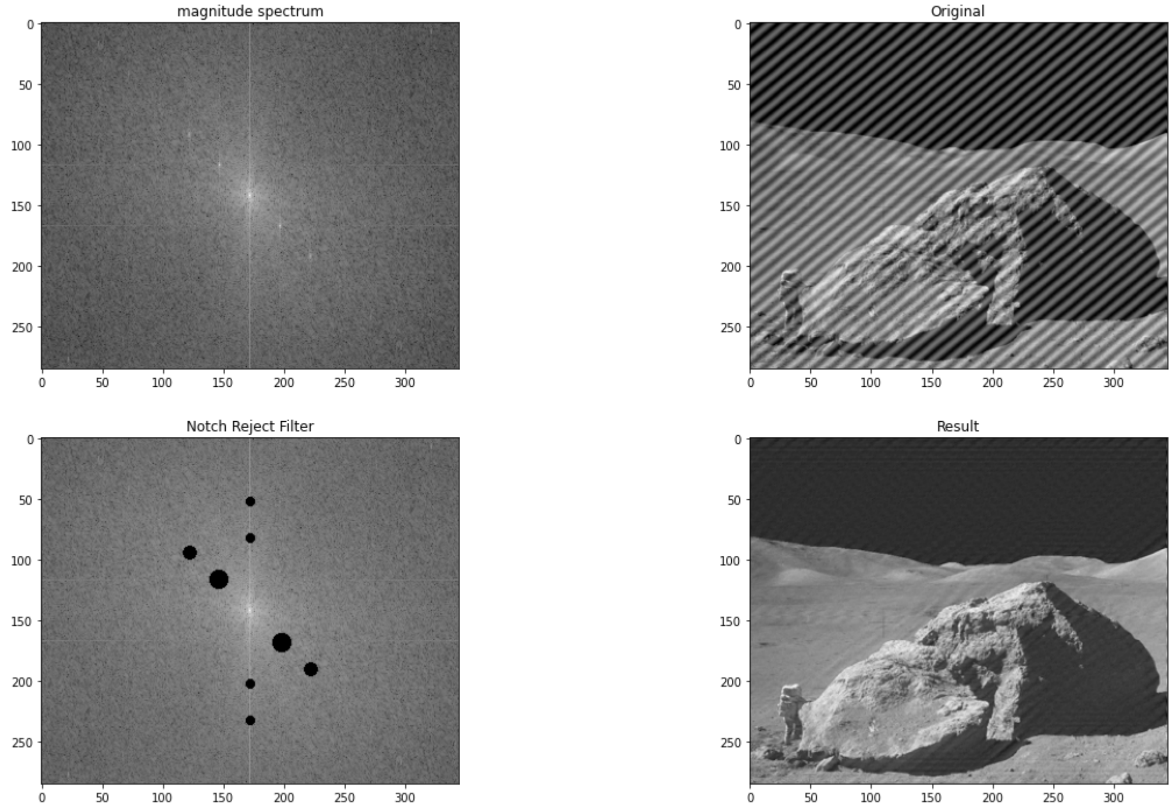
Q1 (1.5pts) Notch reject filter.

<table>
<tr>
<td>Source code</td>
<td>

```python
def notch_reject_filter(shape, d0=9, u_k=0, v_k=0):
    P, Q = shape
    # Initialize filter with zeros
    H = np.zeros((P, Q))

    # Traverse through filter
    for u in range(0, P):
        for v in range(0, Q):
            # Get euclidean distance from point D(u,v) to the center
            D_uv = np.sqrt((u - P / 2 + u_k) ** 2 + (v - Q / 2 + v_k) ** 2)
            D_muv = np.sqrt((u - P / 2 - u_k) ** 2 + (v - Q / 2 - v_k) ** 2)

            if D_uv <= d0 or D_muv <= d0:
                H[u, v] = 0.0
            else:
                H[u, v] = 1.0

    return H
```

</td>
</tr>
<tr>
<td>Input</td>
<td>Output</td>
</tr>
</table>

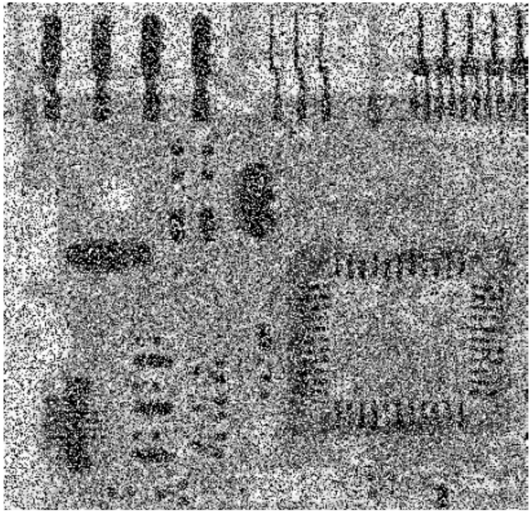
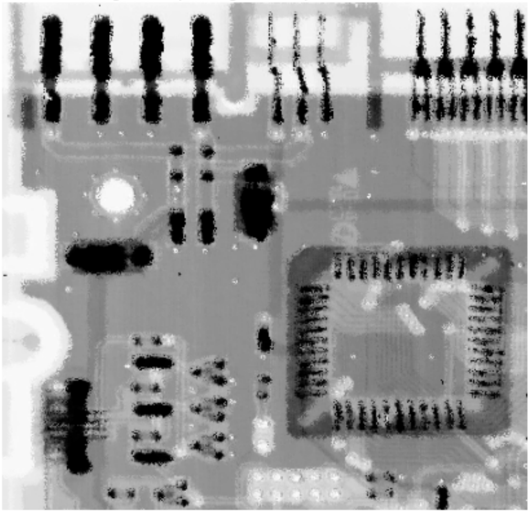


Q2 (1.5pts) Median adaptive filter.

Source code

```
def Median_ad_filter(img,ksize,Smax):
    m,n = img.shape
    img_filtered= np.zeros([m, n])

    h = (Smax-1)//2

    padded_img = np.pad(img,(h,h),mode='reflect')
    for i in range(m):
        for j in range(n):
            k = ksize
            img_k_size = padded_img[i:i+k,j:j+k]

            while True:

                A1 = np.median(img_k_size) -
np.min(img_k_size)
                A2 = np.median(img_k_size) -
np.max(img_k_size)
                if A1 > 0 and A2 <0:

                    B1 = int(img[i, j]) -
int(np.min(img_k_size))
                    B2 = int(img[i, j]) -
```

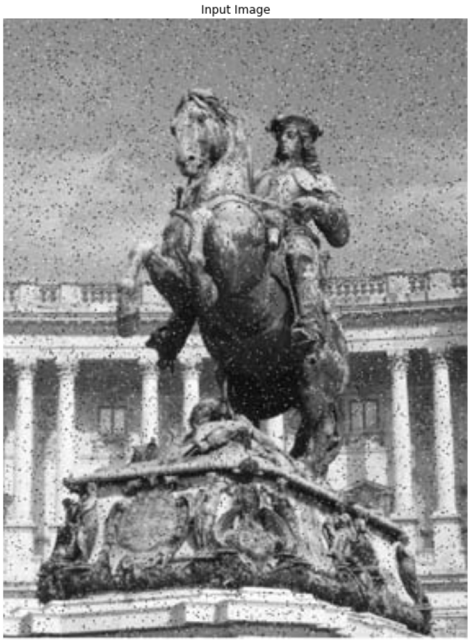
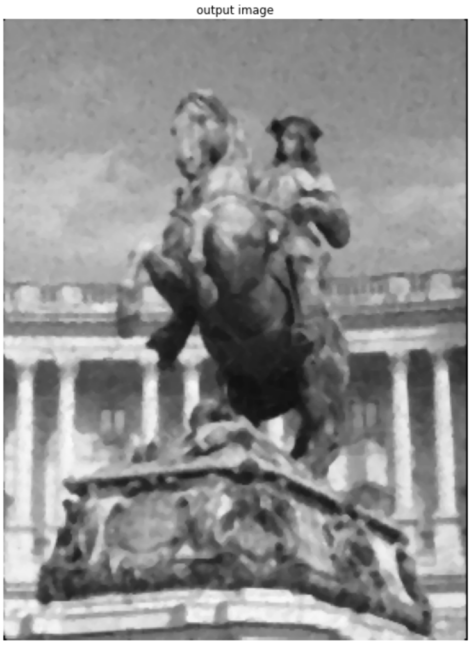
```
int(np.max(img_k_size))
                    if B1>0 and B2 <0:
                        img_filtered[i,j] =
img[i,j]
                    else:
                        img_filtered[i, j] =
np.median(img_k_size)
                    break   #
                else:
                    k += 1
                    Snew = k*2+1
                    if Snew <= Smax :
                        img_k_size =
padded_img[i:i+k,j:j+k]
                    else :
                        img_filtered[i,j] =
np.median(img_k_size)
                        break #
    return img_filtered
```

Input	Output
salt and pepper noise image 	image after passing the Adaptive Median Filter 

Q3 (1.5pts) Median Filter.

Source code

```
def median_filter(data, filter_size):
    temp = []
    indexer = filter_size // 2
    data_final = []
    data_final =
numpy.zeros((len(data),len(data[0])))
    for i in range(len(data)):

        for j in range(len(data[0])):

            for z in range(filter_size):
                if i + z - indexer < 0 or i + z - indexer > len(data) - 1:
                    for c in range(filter_size):
                        temp.append(0)
                else:
                    if j + z - indexer < 0 or j + indexer > len(data[0]) - 1:
                        temp.append(0)
                    else:
                        for k in range(filter_size):
                            temp.append(data[i + z - indexer][j + k - indexer])

            temp.sort()
            data_final[i][j] = temp[len(temp) // 2]
            temp = []
    return data_final
```

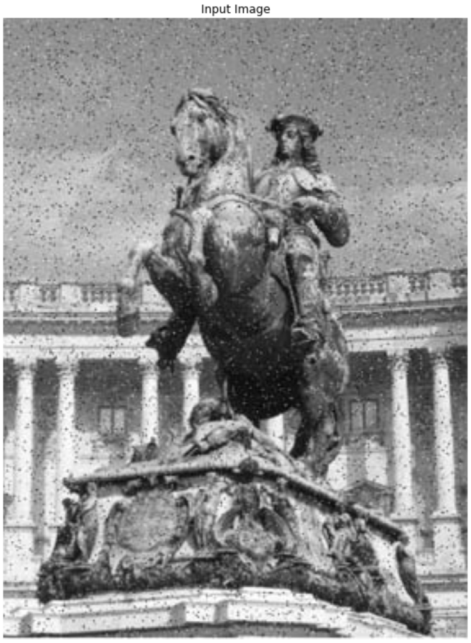
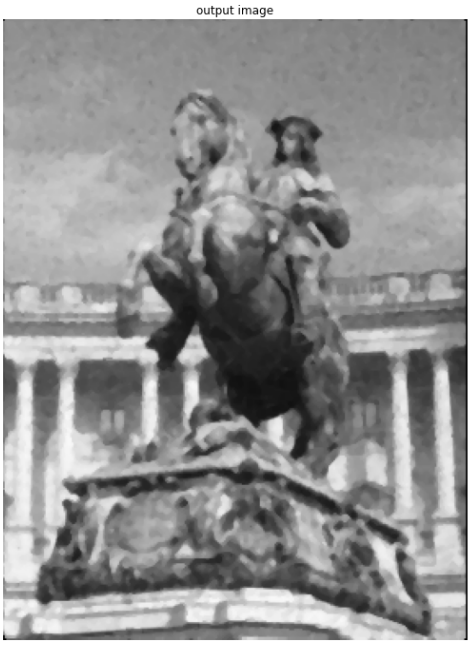
Input	Output
	

Q4 (1.5pts) Motion deblurring .

Source code

```
def blur_edge(img, d=31):
    h, w = img.shape[:2]
    img_pad = cv2.copyMakeBorder(img, d, d, d, d, cv2.BORDER_WRAP)
    img_blur = cv2.GaussianBlur(img_pad, (2*d+1, 2*d+1), -1)[d:-d, d:-d]
    y, x = np.indices((h, w))
    dist = np.dstack([x, w-x-1, y, h-y-1]).min(-1)
    w = np.minimum(np.float32(dist)/d, 1.0)
    return img*w + img_blur*(1-w)
```

```
def kernel_motion(angle, d, sz=65):
    kern = np.ones((1, d), np.float32)
    c, s = np.cos(angle), np.sin(angle)
    A = np.float32([[c, -s, 0], [s, c, 0]])
    sz2 = sz // 2
    A[:,2] = (sz2, sz2) - np.dot(A[:,:2],
((d-1)*0.5, 0))
    kern = cv2.warpAffine(kern, A, (sz, sz),
flags=cv2.INTER_CUBIC)
    return kern
```

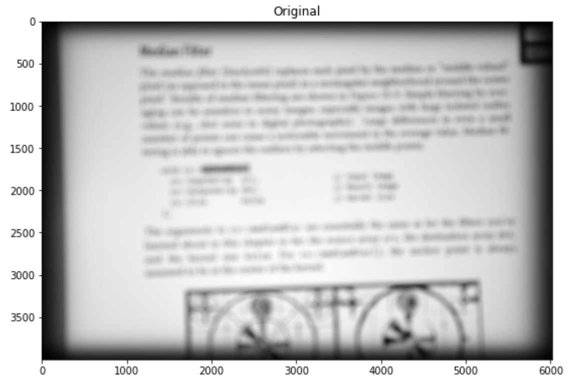
Input	Output
 Input Image	 output image

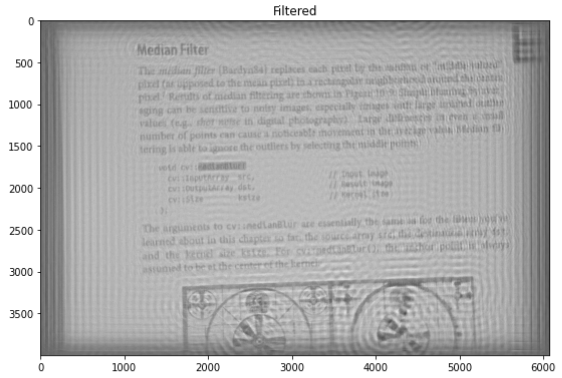
Q5 (1.5pts) Median Filter.

Source code

```
  def calcPSF(size, R):

   h = np.zeros(size, dtype=np.float32)
   cv.circle(h,(size[1]//2,size[0]//2), R, 1, -1)
   psf = h/np.sum(h)

   return psf

def calcWnrFilter(psf, SNR):

    h_psf = np.fft.fftshift(psf)
    h_planes = [np.float32(h_psf),
np.zeros(h_psf.shape, np.float32)]
    h_complexI = cv.merge(h_planes)
    h_complexI = cv.dft(h_complexI)
    h_planes = cv.split(h_complexI)
    denom = np.power(np.abs(h_planes[0]),2) +
(1/SNR)
    wiener = np.divide(h_planes[0], denom, dtype =
np.float32)

    return wiener

def filter2DFreq(img, wiener):

    planes = [np.float32(img), np.zeros(img.shape,
np.float32)]
    complexI = cv.merge(planes)
    complexI = np.divide(cv.dft(complexI),
complexI.size, dtype = np.float32)

    planesH = [np.float32(wiener),
np.zeros(wiener.shape, np.float32)]
    complexH = cv.merge(planesH)
    complexIH = cv.mulSpectrums(complexI,
complexH, 0)

    complexIH = cv.idft(complexIH)
    planes = cv.split(complexIH)
    out = planes[0]

    return out

def deBlur(img, R, SNR):

    rows, cols = img.shape
    m = cv.getOptimalDFTSize( rows )
    n = cv.getOptimalDFTSize( cols )
    img = (cv.copyMakeBorder(img, 0, m - rows, 0,
n - cols, cv.BORDER_CONSTANT, value=[0, 0,
0])/255).astype(np.float32)

    h = calcPSF((m,n), R)
    Hw = calcWnrFilter(h, SNR)
    out = filter2DFreq(img, Hw)

    return out
```

Input	Output

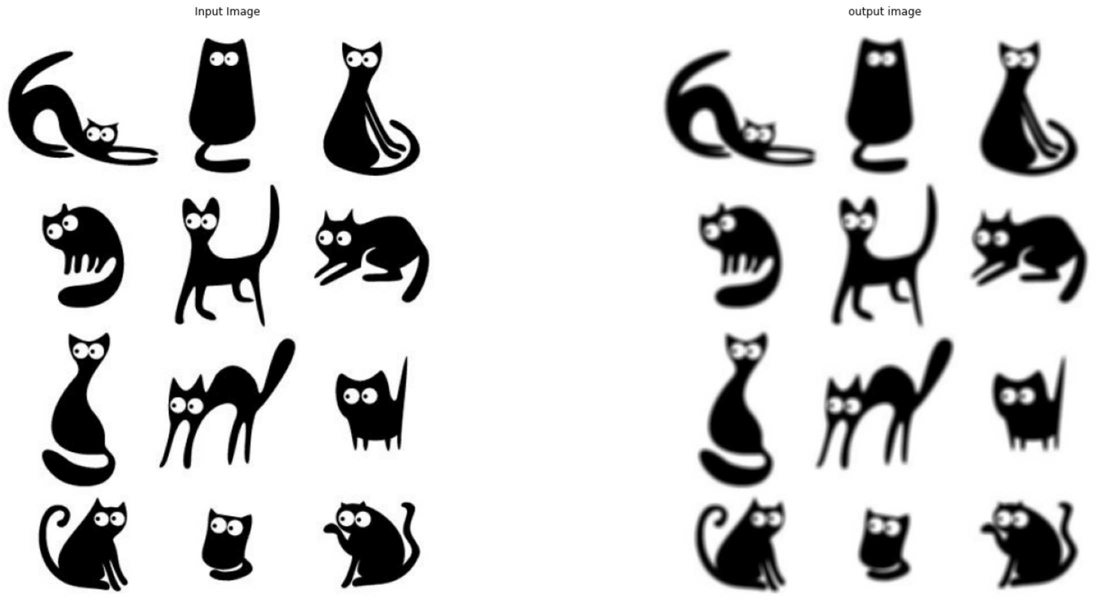




Q6 (1.5pts) image anti-aliasing.

Source code

```
   # convert to gray
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# threshold
thresh = cv2.threshold(gray, 32, 255,
cv2.THRESH_BINARY)[1]

# blur threshold image
blur = cv2.GaussianBlur(thresh, (0,0), sigmaX=3,
sigmaY=3, borderType = cv2.BORDER_DEFAULT)

# stretch so that 255 -> 255 and 127.5 -> 0
stretch = skimage.exposure.rescale_intensity(blur,
in_range=(127.5,255),
out_range=(0,255)).astype(np.uint8)

# threshold again
thresh2 = cv2.threshold(stretch, 0, 255,
cv2.THRESH_BINARY)[1]

# get external contour
contours = cv2.findContours(thresh2,
cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
contours = contours[0] if len(contours) == 2 else
contours[1]
big_contour = max(contours, key=cv2.contourArea)

# draw white filled contour on black background
contour = np.zeros_like(thresh, dtype=np.uint8)
cv2.drawContours(contour, [big_contour], 0, 255,
-1)

# dilate mask for dark border
kernel =
cv2.getStructuringElement(cv2.MORPH_ELLIPSE,
(20,20))
mask = cv2.morphologyEx(contour, cv2.MORPH_DILATE,
kernel)

# create red colored background image
bckgrnd = np.full_like(img, (0,0,255),
dtype=np.uint8)

# apply mask to img
img_masked = cv2.bitwise_and(img, img, mask=mask)

# apply inverse mask to colored background image
bckgrnd_masked = cv2.bitwise_and(bckgrnd, bckgrnd,
mask=255-mask)

# combine the two
result = cv2.add(img_masked, bckgrnd_masked)
# Creating the kernel with numpy
kernel2 = np.ones((5, 5), np.float32)/25
```

<table>
<tr><td></td><td># Applying the filter
result= cv2.filt</td></tr>
<tr><td>Input</td><td>Output</td></tr>
<tr><td colspan="2">
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