Digital Image Processing & Pattern Recognition
UPEC - Optics, Image, Vision and Multimedia

1. Operators

1.1. Directions

Use the *skimage.filter* with 'sobel' and 'prewitt' options for filtering image "T". Why saying that these filters are Sobel or Prewitt horizontal edge-emphasizing ones? Use transpose operator ' and rot90 function to define the kernel adapted to all directions. Call them North, South, West and East.

1.2. Convolution

Apply these kernels to the image using *filter function* with 'replicate' option for boundary problem. In Python, you can achieve similar functionality using the *mode='nearest'* or *mode='reflect'* optionsin *scipy.ndimage.convolve* or *scipy.ndimage.generic_filter*. Take the maximum value on each pixel and create that way the output image.

2. Gradient operator

2.1. Magnitude

Use the gradient function on an image (for example T) to extract both Jx and Jy - partial derivatives along horizontal and vertical directions. Be careful to transform the image in double type if needed. Then use *sqrt* to compute the magnitude on each point and show the result using uint8 type.

2.2. Edge function

Use directly "*edge*" to extract edges in an image T with different options.

2.3. Gradient vector

To visualize better the gradient vectors, use the function *quiver*:

```
imagesc(I); colormap(gray)
hold on
for i=1:10:size(I,1)
for j=1:10:size(I,2)
quiver(j,i,Jx(i,j),Jy(i,j),'r')
end
end
hold off
```

3. Spatial domain filtering

3.1. In order to filter an image in the spatial domain, one of the techniques is to perform a convolution of it with a mask. For this, you can use the function conv2 in the following manner:

```
H1=1/9*[1 1 1;1 1 1;1 1 1];
filtI = conv2(I,H1);
```

Now, test the following filters and describe their effect on images:

$$H1 = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \quad H2 = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix} \quad H3 = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

The filter H1 is called the averaging, the filter H2 is a vertical gradient, you can try the horizontal version and obtain all of the contours of the image. The filter H3 is the Laplacian, what is the advantage of it?

3.2. Try the median filter, what effect does it have on the images?

```
J = imnoise(I,'salt & pepper',0.02);
K = medfilt2(J);
imshowpair(J,K,'montage')
```

3.3. What filter would you use on the following images (lena1, lena2, lena3, lena4) to filter/enhance them?