# Computer Vision

## Assignment -1

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1. Given:
   a. f = [1 2 1], X = [0 1 2 3 4 4 1 5 6]
      i. Using zero padding
         X` = [0 0 1 2 3 4 4 1 5 6 0]
         => f*X` = **[1 4 8 12 15 13 11 17 17]**
      ii. Using boundary replication
         X' = [0 0 1 2 3 4 4 1 5 6 6]
         => f*X` = **[1 4 8 12 15 13 11 17 23]**
   b. f = [1 0; 0 1], X= [1 0 0; 0 0 1; 0 0 -1]
      i. Using zero padding
         X` = [0 0 0 0; 0 1 0 0; 0 0 0 1; 0 0 0 -1]
         => f*X` = **[ 1 0 0; 0 1 1; 0 0 -1]**
      ii. Using boundary replication
         X`= [1 1 0 0; 1 1 0 0; 0 0 0 1; 0 0 0 -1]
         =>f*X` = **[2 1 0; 1 1 1; 0 0 -1]**

2. **No effect** on swapping the two operations as convolution operation is commutative. The result will remain the same. The reason to do smoothening before the image gradient was to remove the noises(salt-pepper like noise) from the gradients as they affect the result and are not a part of edges.

3. Canny edge detection is composed of:
   a. **Noise reduction**
   b. **Gradient calculation**
   c. **Non-maximum suppression**
   d. **Double threshold**
   e. **Edge tracking**

   Mathematically for noise reduction smooth it with a Gaussian filter

   g(m, n) = $G_\sigma(m, n) * f(m, n)$

   $G_\sigma$ is Gaussian function

   After this compute the gradient of g(m, n) using Sobel filter to get

   M(m, n) = $\sqrt{g_m^2(m, n) + g_n^2(m, n)}$

   $\Theta$ (m, n) = $tan^{-1}|g_n(m, n)/g_m(m, n)|$

   Threshold M:

   $M_T(m, n) = \{M(m, n) \; if \; M(m, n) > T; \; 0 \; otherwise\}$

   Where T is chosen to suppress noise most of the noise.

Suppress non-maxima pixels in the edges in $M_T$

$$M_T(m,\ n)\ =\ \{M_T(m,\ n)\ if\ M_T(m,\ n) > \ two\ neighbours\ along\ \Theta(m,\ n)\ ;\ 0\ otherwise\}$$

Threshold the result by two different thresholds ( $T_1,\ T_2$ ) where $T_1 < T_2$ to obtain two binary images. Image with $T_2$ has less noise and fewer false edges but greater gaps between edge segments.

Link edge segment in $M_{T_2}$ to form continuous edges. I.e. trace each segment in $M_{T_2}$ to its end and then search its neighbor in $M_{T_1}$ to find any edge segment to bridge the gap until reaching another edge segment in $M_{T_2}$ .

4. The question is missing.

5. There is a **trade-off** between **intensity and blurriness**. To get a clear image we require small-sized pinhole, but reducing the pinhole size also decreases the intensity of light falling on the image plane. So we kept decreasing the size until we get a visually clear image. **Advantage** of having small-sized pinhole: The image will be less blurred or more clear. **Disadvantage**: The intensity will decrease which might cause the image to not be detected.

6. Affine matrix for scaling followed by translation =
[[ $s_x cos\Theta - s_x sin\Theta$ 0], [ $s_y$ sin $\Theta$ $s_y$ cos $\Theta$ 0], [0 0 1]] as given in the problem it is equal to
[[1 1 0], [-1 1 0], [0 0 1]]
=> on solving we get $s_y$ **=** $s_x$ **=** $\sqrt{2}$ **and** $\Theta$ **= 45 degree clockwise or 315 anticlockwise.**