EE 416 – Image Processing and Computer Vision **(UH Manoa, Fall 2020)**

Homework Assignment #4

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Problem 1, a)

We know that:

$$x[n] \rightarrow \uparrow U \rightarrow H(e^{i\omega}) \rightarrow y[n]$$

$$Therefore$$

$$x[m,n] \rightarrow \uparrow 2 \rightarrow H(e^{i\mu}, e^{i\nu}) \rightarrow y[n]$$

$$h[m,n] = h[-k,-l] = \begin{bmatrix} 0.25 & 0.5 & 0.25 \\ 0.5 & 1 & 0.5 \\ 0.25 & 0.5 & 0.25 \end{bmatrix}$$

$$x_2[m,n] = \begin{bmatrix} 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$y[m,n] = \begin{bmatrix} 0 & 0.5 & 1 & 1 & 1 \\ 0 & 0.5 & 1 & 1 & 1 \\ 0 & 0.5 & 1 & 1 & 1 \\ 0 & 0.25 & 0.5 & 0.5 & 0.5 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Problem 1, b)

$$\begin{aligned} H(e^{i\mu}, e^{i\nu}) &= \sum_{m,n=-1}^{1} 0.5^{|m+n|} e^{-i(\mu m + \nu n)} \\ &= \sum_{m=-1}^{1} 0.5^{|m|} e^{-i(\mu m)} \sum_{n=-1}^{1} 0.5^{|n|} e^{-i(\nu n)} \\ &= (0.5e^{i\mu} + 1 + 0.5e^{-i\mu})(0.5e^{i\nu} + 1 + 0.5e^{-i\nu}) \\ &= (1 + cos\mu)(1 + cos\nu) \end{aligned}$$

Problem 1, c)

$$Y(e^{i\mu}, e^{i\nu}) = \sum_{k,l=0}^{1} H(e^{\frac{i(\mu - 2\pi k)}{2}}, e^{\frac{i(\nu - 2\pi l)}{2}}) X(e^{\frac{i(\mu - 2\pi k)}{2}}, e^{\frac{i(\nu - 2\pi l)}{2}})$$

Problem 1, d)

The advantages of interpolation methods is that they are simple since they are used to simplify our signals by sampling them. It also improves anti-aliasing filter performance and reduces noise.

The disadvantages of interpolation method is that we require a higher sample rate in order to have a good resolution conversion.