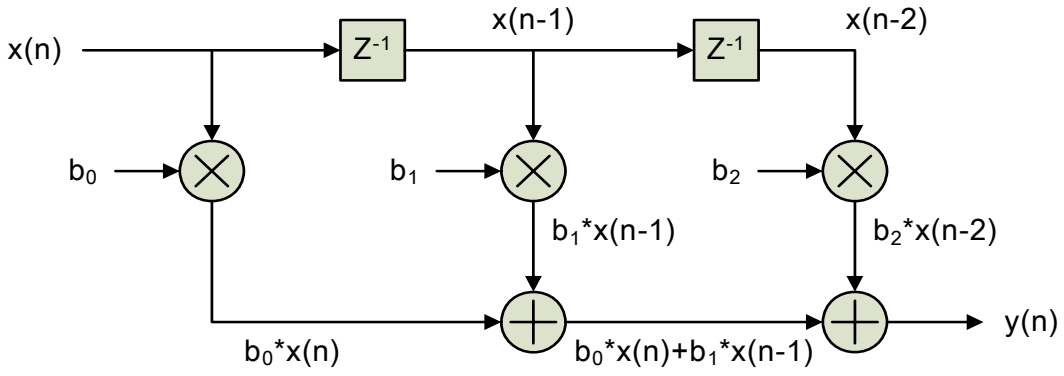
DSP in VLSI Design
Homework (I)

Introduction to Digital Signal Processing Systems
Reference Answer

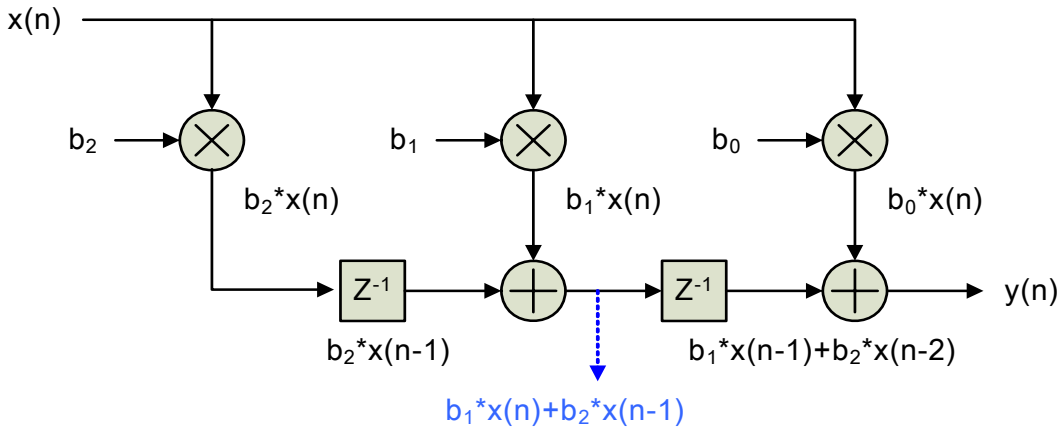
1. 1. Please prove that the circuits in Page 32 and Page 33 are equivalent. (Please refer to 課程投影片 1_introduction.pdf)

P.32 :



$$y(n)=b_0*x(n)+b_1*x(n-1)+b_2*x(n-2)$$

P.33 :



$$y(n)=b_0*x(n)+b_1*x(n-1)+b_2*x(n-2)$$

所以兩個電路具有相同的意義.

2. Consider a 2D moving average filter for an image, which can be shown as the following equation:

$$y(i,j)=\sum_{m=-1}^{1}\sum_{n=-1}^{1}x(i+m,j+n),$$

$$i,i+m\in[0,W]$$

$$j,j+n\in[0,H]$$

where x(i,j) is the input image, y(i,j) is the filtered image, and W and H are the width and height of the image, respectively. Please draw the dependence graph.

$$y(i,j)=\sum_{m=-1}^{1}\sum_{n=-1}^{1}x(i+m,j+n)$$

$$y(i,j)=\sum_{m=-1}^{1}x(i+m,j-1)+\sum_{m=-1}^{1}x(i+m,j)+\sum_{m=-1}^{1}x(i+m,j+1)$$

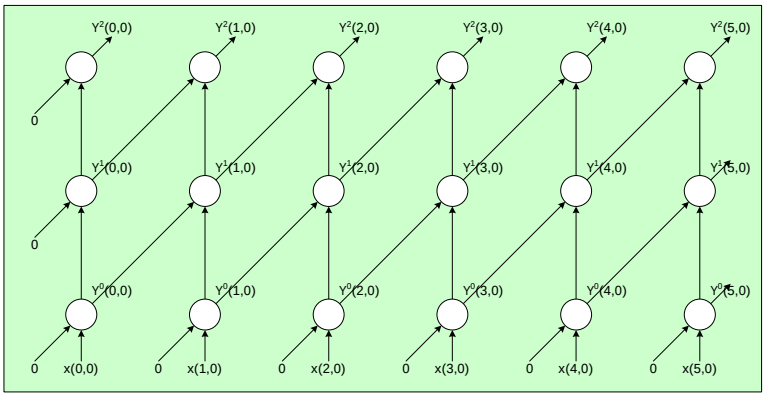
$$y(i,j)=y_{-1}(i,j)+y_0(i,j)+y_1(i,j)$$

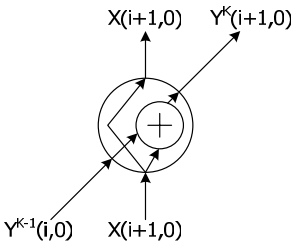
For $y_{-1}(i,j)=\sum_{m=-1}^{1}x(i+m,j-1)$, translate to recursive form (single assignment)

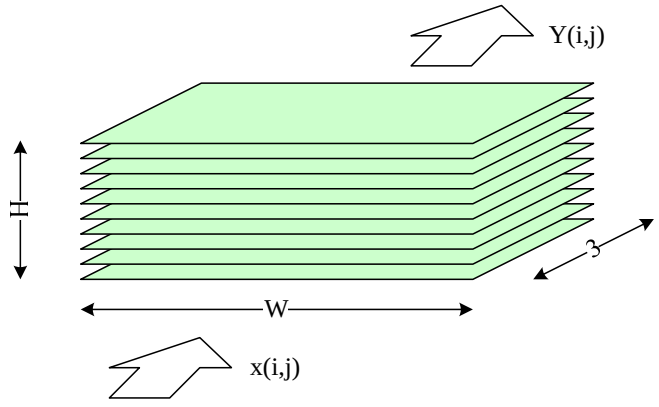
$$Y_{-1}^{K}(i+1,j-1)=Y_{-1}^{K-1}(i,j-1)+x(i+1,j-1)$$

$$Y_{-1}^{K}(i,j-1)=0\ if\ K<0$$

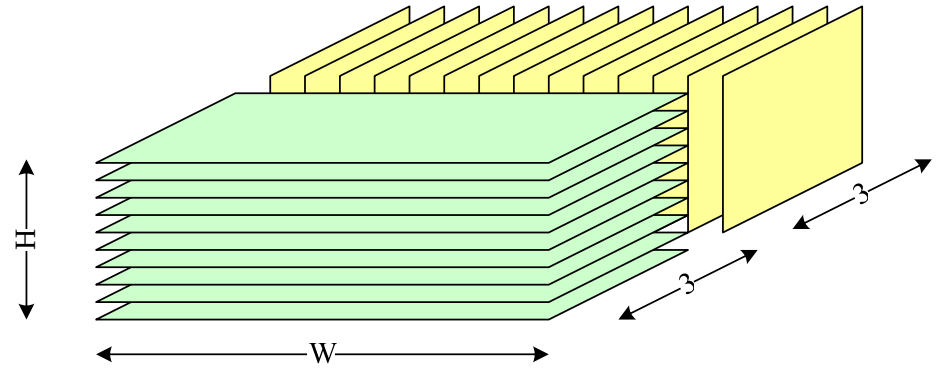
$$(\ Y_{-1}^{2}(i+1,j-1)=y_{-1}(i,j-1)\ )$$







After Y^2 plane has been generated, apply similar method but only change vertical / horizontal direction to generate $y(i,j) = y_{-1}(i,j) + y_0(i,j) + y_1(i,j)$



Note:

The prediction methods of Problem 1 can be very different.

DG graphs also can be presented by various forms.

It's just a **reference answer**.