ECE 178, CY (Chengyuan) Xu, 11am

**3.15**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |
| 2 |  | ­center |  |  |
| 3 |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |
| 2 | ­center |  |  |  |
| 3 |  |  |  |  |

Figure (a) and (b)

(1) To better explain the process, please refer to figure (a) and (b) above. The gray area is the assumed 3\*3 box filter. To apply a lowpass filter, we sum all values of the gray area in figure (a), which is (row 1-3, column 1-3) and divide by nine, to get the value for center pixel.

To get the next center pixel, we move the filter right by one column, but this time we don’t have to recalculate all values again, just remove the sum of column one and add the sum of column four (and divide by nine). To express it in formula, it’s (F’ = F + ColumnNew – ColumnOld). When the box finishes the last column, it moves down one row and start moving backwards.

(2) The box filter approach, assume we have finished figure (a) and move to figure (b): (1,4) + (2,4) + … + (n,4) + (sum of previous box) – (sum of column one) = n + 1 steps. (normalization ignored.)

The brute force approach will need to add all pixels again, which is (n \* n – 1) steps.

So the computational advantage in this case is (n2 – 1) / n + 1 => (n - 1)

**3.19**

(a) List all values of the neighborhood in a row from small to big, find the number on the list and it’s the median value.

(b) Similar to question 3.15, to get the new median value, subtract values of the old column and add the number of new column, arrange them in order and find the median again.

**3.22**

Assume the background is all 0s, as shown in Fig 3.34. If we use a mask of size (, then the object (size ) must be smaller than the mask.

In order to get the average intensity of the object to the of original value, we assume size of

and average intensity of the object , so the result should be 1. Total number of other pixels in the mask is , there values are 0. And we finally normalize them by the number of total pixels. We get this equation:

solve the equation we get , in which case the size of object is , so the minimum ratio of the object and the mask is .

Since the object won’t be exactly same as the area , so n should be smaller and the ratio should be