Convolution using Overlap method

1\. Overlap save

Let $x(n) = \{1, 2, 3, 4, 5, 6, 7\}$

& $h(n) = \{1, 0, 2\}$

Important Notations

N = Length of each block

M = Length of $h(n)$

L = Values from current $x(n)$

$\therefore \quad N = (M-1) + L$

Here, $M = 3$

In this method, each block contains $(M-1)$ data points of the previous block followed by L new data points.

For the first block, the first '$(M-1)$' values are set to 0.

In our case $M-1 = 2$. we choose $N = 5$; $L = 3$

$x(n) = \{1, 2, 3, 4, 5, 6, 7\}$

$\therefore \; x_1(n) = \{0, 0, 1, 2, 3\}$

$x_2(n) = \{2, 3, 4, 5, 6\}$

$x_3(n) = \{5, 6, 7, 0, 0\}$

Now $h(n) = \{1, 0, 2\}$

Since the block size $= 5$, we append 2 zeros to $h(n)$

$\therefore \; h(n) = \{1, 0, 2, 0, 0\}$

We now perform convolution

$\therefore \; y_1(n) = x_1(n) \circledast h(n) = \{4, 6, 1, 2, 5\}$

$\therefore \; y_2(n) = x_2(n) \circledast h(n)$

$= \{12, 15, 8, 11, 14\}$

$\therefore \; y_3(n) = x_3(n) \circledast h(n)$

$= \{5, 6, 17, 12, 14\}$

We arrange the results with an overlap of $(M-1)$ values. In short, we discard the first $(M-1) = 2$ values of each result.

4 6 1 2 5

Discard

12 15 8 11 14

Discard

5 6 17 12 1

Discard

$\therefore \quad y(n) = \{1, 2, 5, 8, 11, 14, 17, 12,$

We check the result by performing linear convolution

$$y(n) = x(n) * h(n)$$

$x(n) \rightarrow$

$h(n) \downarrow$	1	2	3	4	5	6	7
1	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0
2	2	4	6	8	10	12	14

$y(n) = \{1, 2, 5, 8, 11, 14, 17, 12, 14$

Overlap → Add method

In this method, each block is created by taking L values from $x(n)$ and appending $(M-1)$ zeros at the end of each block.

The size of each block is $N = L + (M-1)$

$x(n) = \{1, 2, 3, 4, 5, 6, 7\}$

& $h(n) = \{1, 0, 2\}$

In this, the input is divided into blocks of data of size L and $(M-1)$ zeros are appended to it. This makes the size of data blocks $N = L + (M-1)$

In our example, we choose a block size of $N = 5$.

Since $h(n)$ has a length of 3, we append $M-1 = (3-1) = 2$ zeros to L.

The length of $L = 3$

$\therefore\ x(n) = \{1, 2, 3, 4, 5, 6, 7\}$

$x_1(n) = \{1, 2, 3, 0, 0)$

$x_2(n) = \{4, 5, 6, 0, 0)$

$x_3(n) = \{7, 0, 0, 0, 0\}$

We increase the size of $h(n)$ by appending zeros so that it is equal to $N=5$

$$\therefore h(n) = \{1, 0, 2, 0, 0\}$$

We now perform circular convolution

$$\therefore y_1(n) = x_1(n) \circledast h(n)$$
$$= \{1, 2, 5, 4, 6\}$$

$$y_2(n) = x_2(n) \circledast h(n) = \{4, 5, 14, 10, 12\}$$

$$y_3(n) = x_3(n) \circledast h(n) = \{7, 0, 14, 0, 0\}$$

These results are placed as shown below and added. The last 2 terms are added. Since we had appended 2 zeros to $h(n)$

$$
\begin{array}{ccccccccc}
y = 1 & 2 & 5 & 4 & 6 & & & & \\
 & & & \downarrow & \downarrow & \text{Add} & & & \\
 & & & 4 & 5 & 14 & 10 & 12 & \\
 & & & & & & \downarrow & \downarrow & \text{Add} \\
 & & & & & & 7 & 0 & 14 \; 0 \; 0
\end{array}
$$

$$\therefore y(n) = \{1, 2, 5, 8, 11, 14, 17, 12, 14\}$$

We would have got the same answer had we performed linear convolution as shown earlier.

$\therefore x_1($