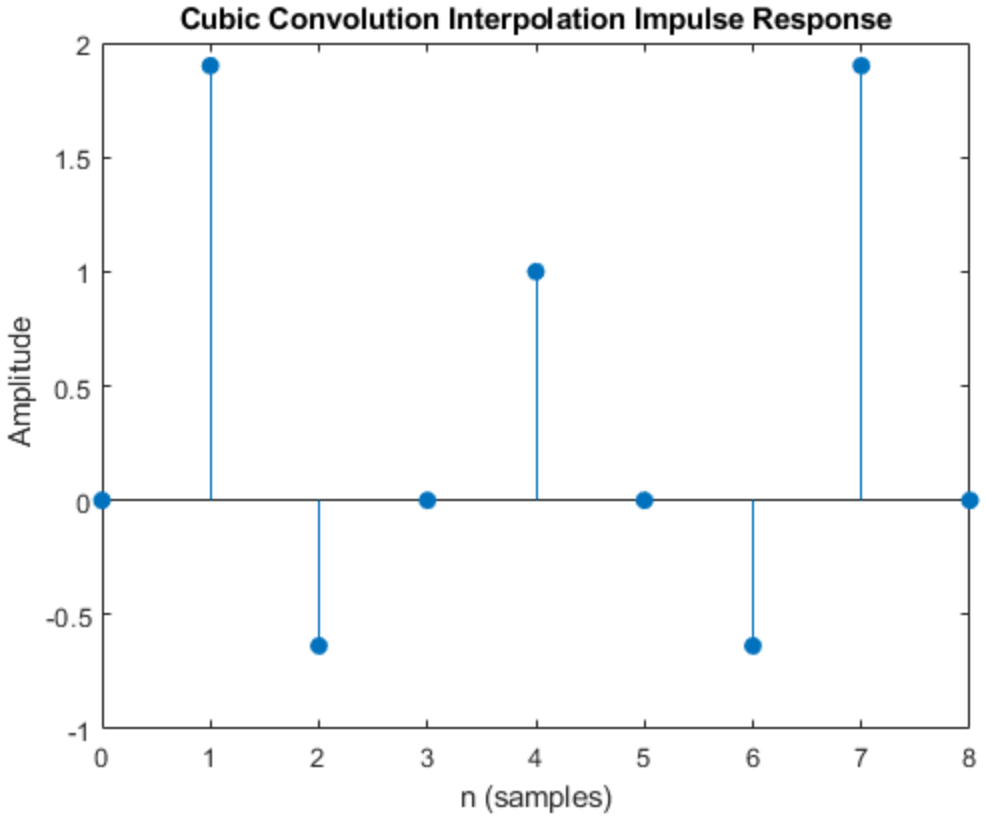
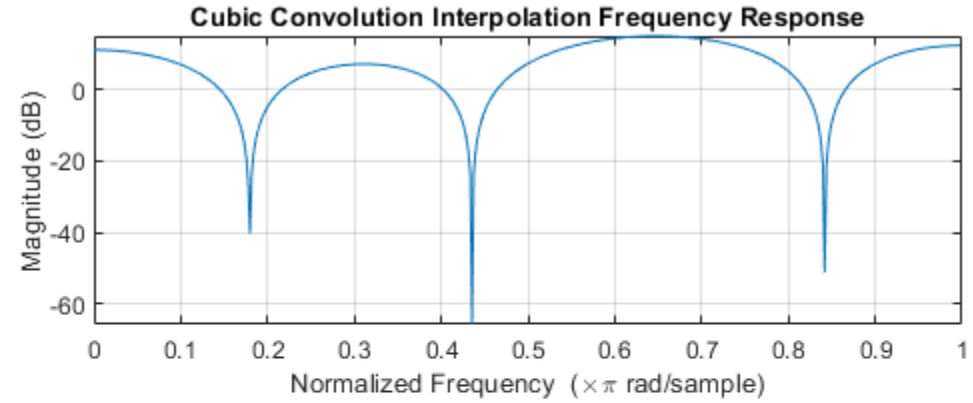
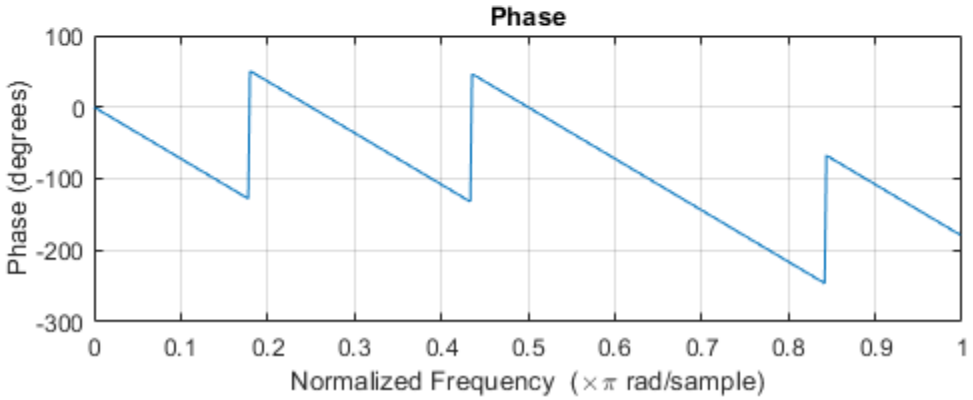
PROJECT – 2

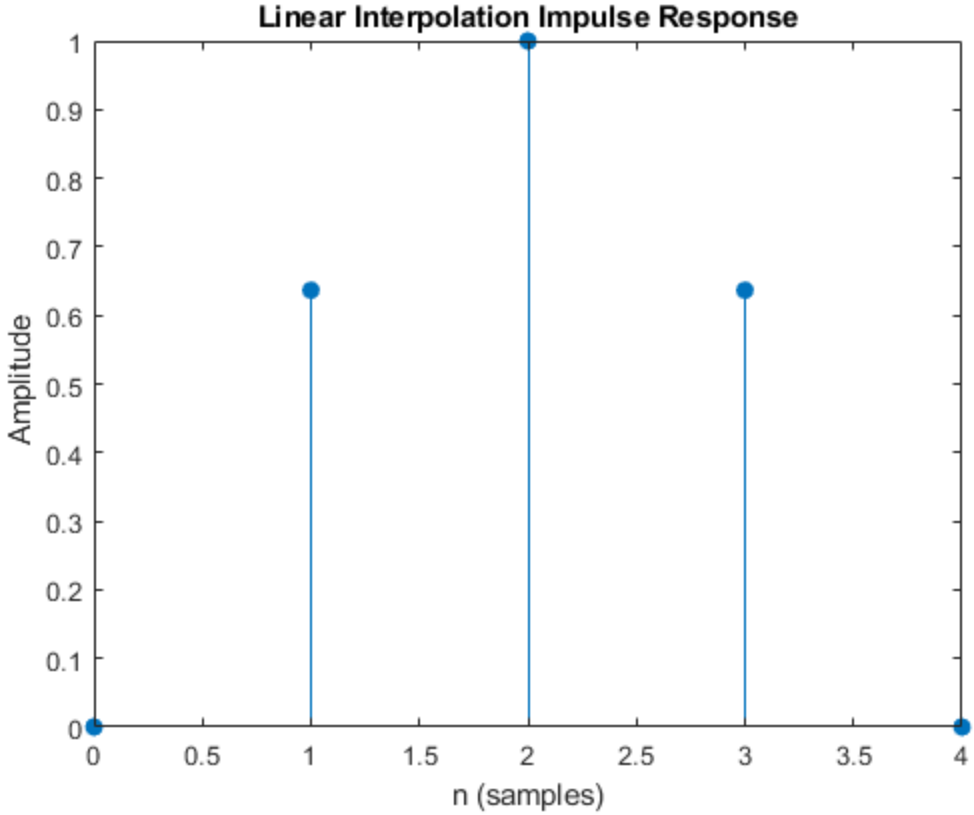
Elkhan Ismayilzada

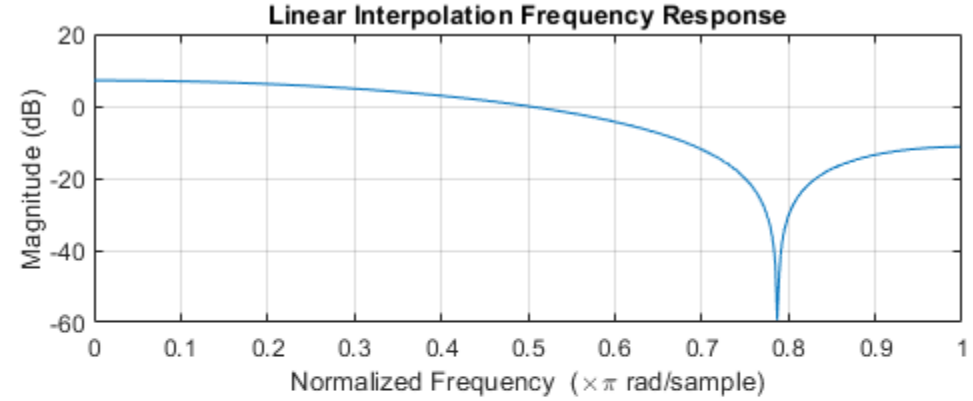
For 1D sampling rate conversion for x2 conversion, find the interpolation filters for sample-and-hold, linear interpolation, and cubic convolution interpolation (a=-0.5). Plot the impulse and magnitude responses of the filters.

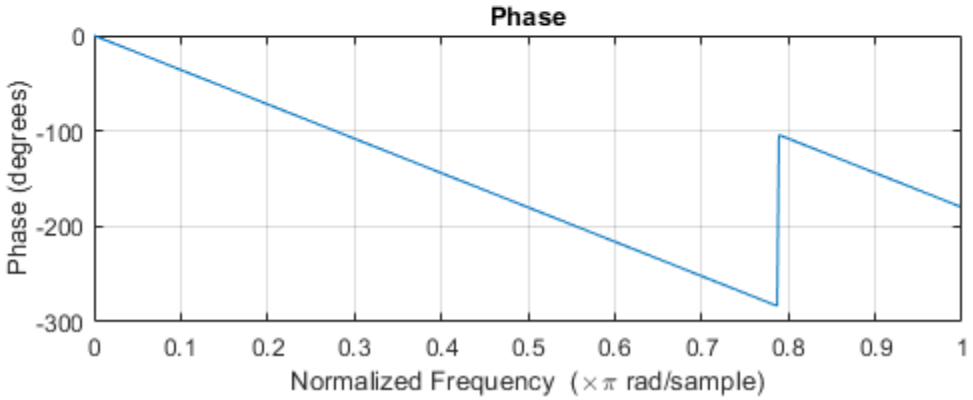


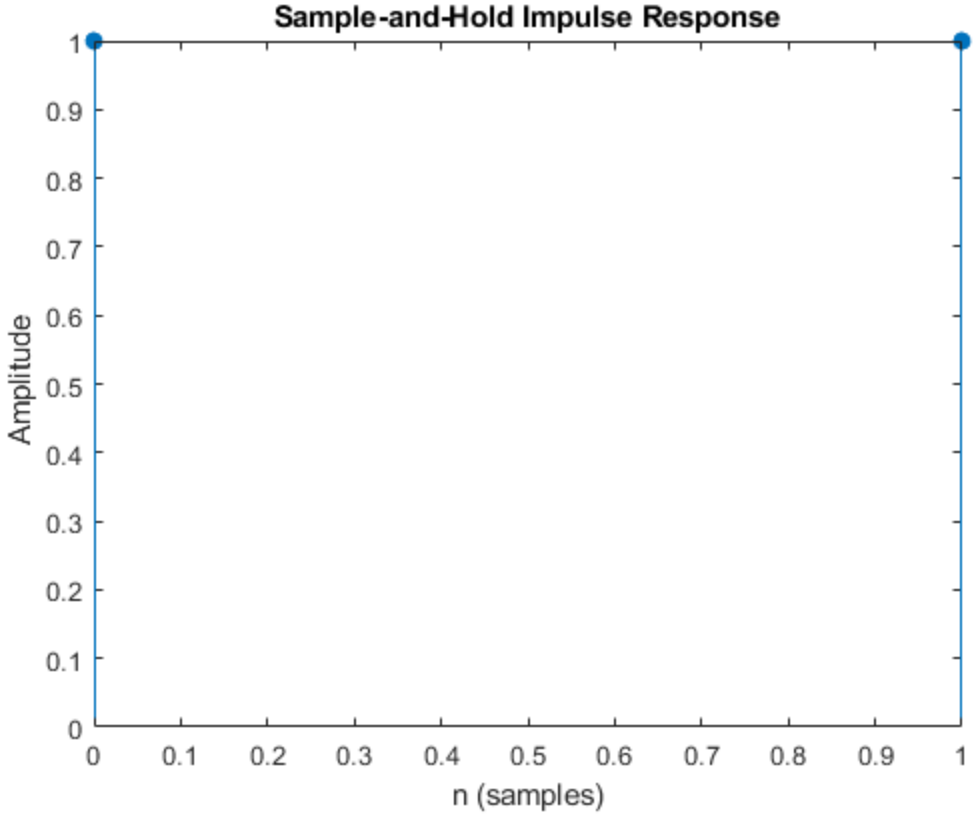

Cubic Convolution Interpolation Frequency Response
Magnitude (dB)
0
-20
-40
-60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)

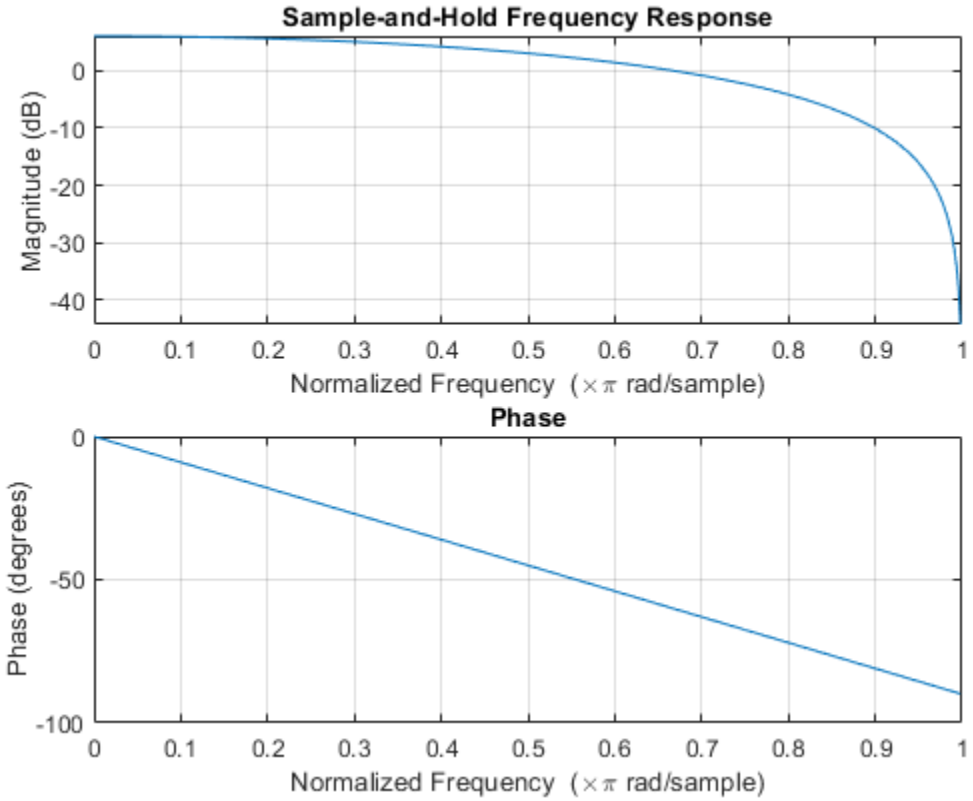

Phase
Phase (degrees)
100
0
-100
-200
-300
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)


Linear Interpolation Impulse Response
Amplitude
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5
4
n (samples)

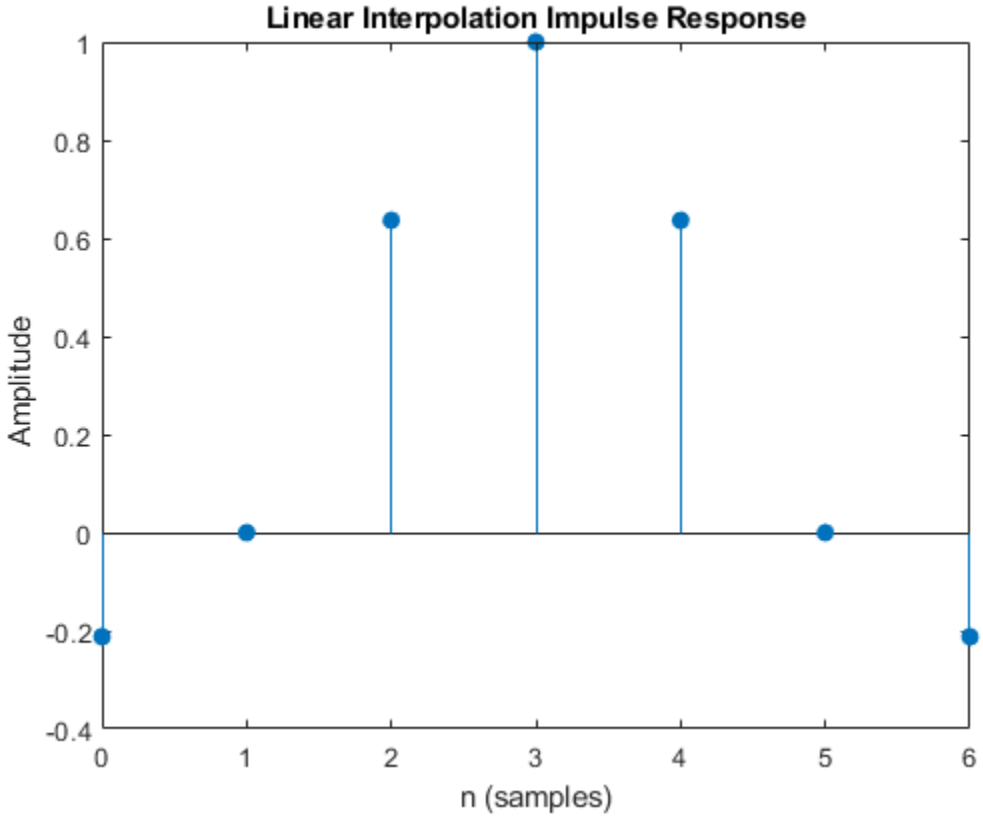

Linear Interpolation Frequency Response
Magnitude (dB)
20
0
-20
-40
-60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)

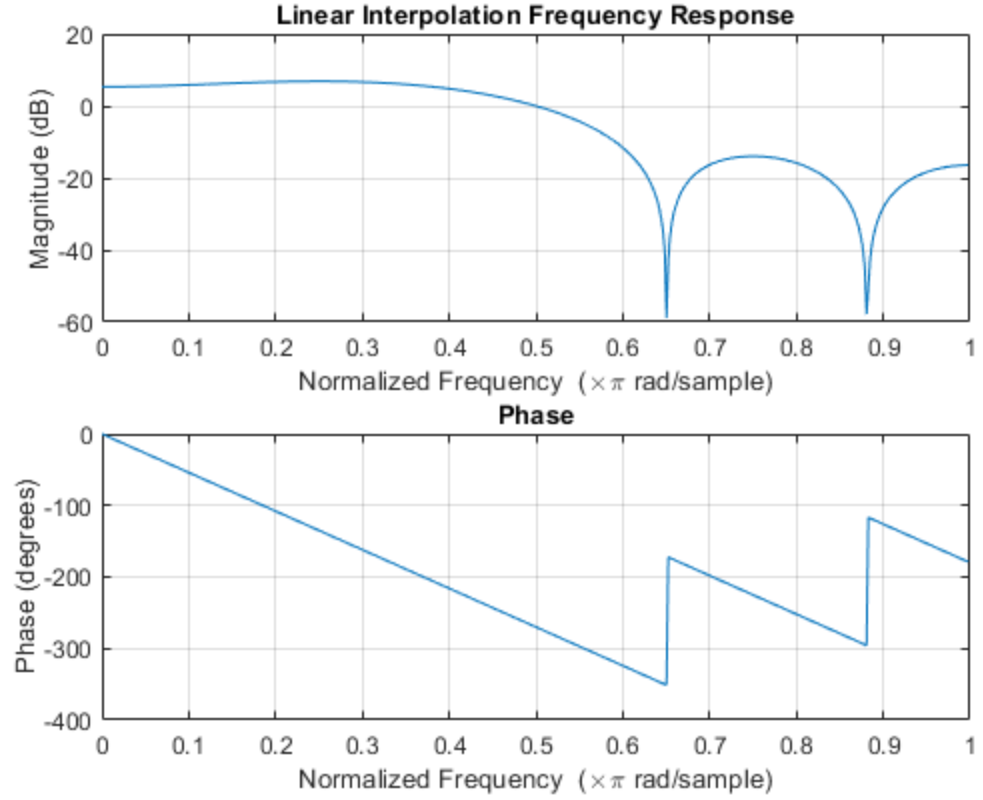

Phase
Phase (degrees)
0
-100
-200
-300
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)

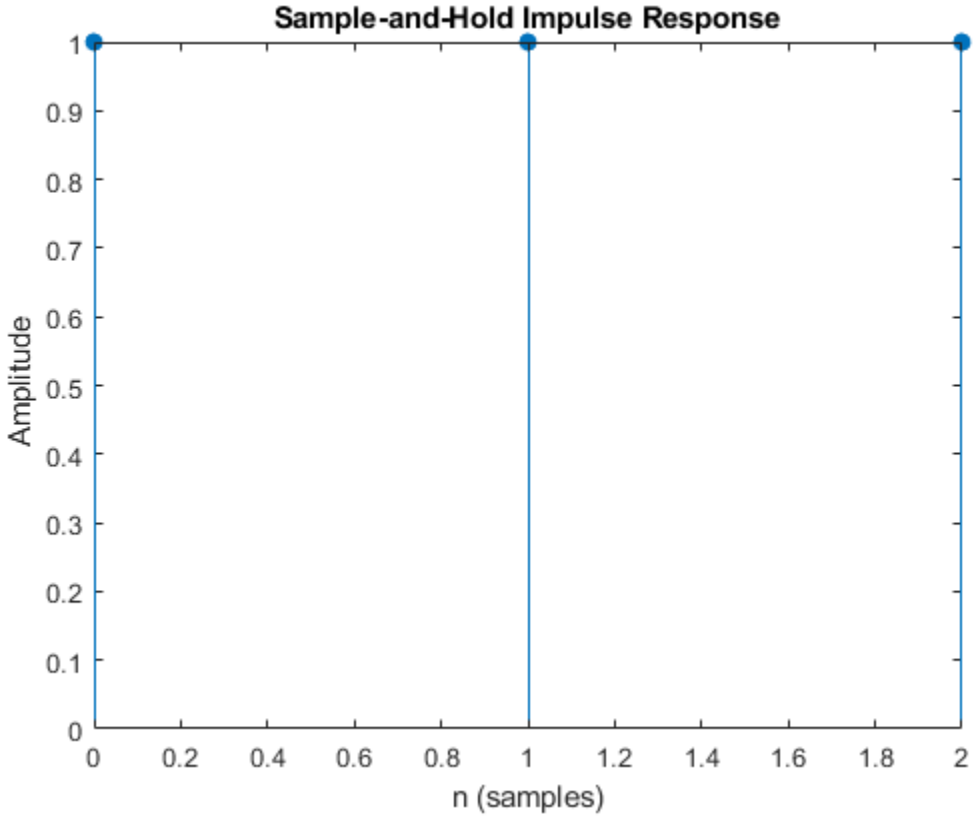

Sample-and-Hold Impulse Response
Amplitude
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
n (samples)

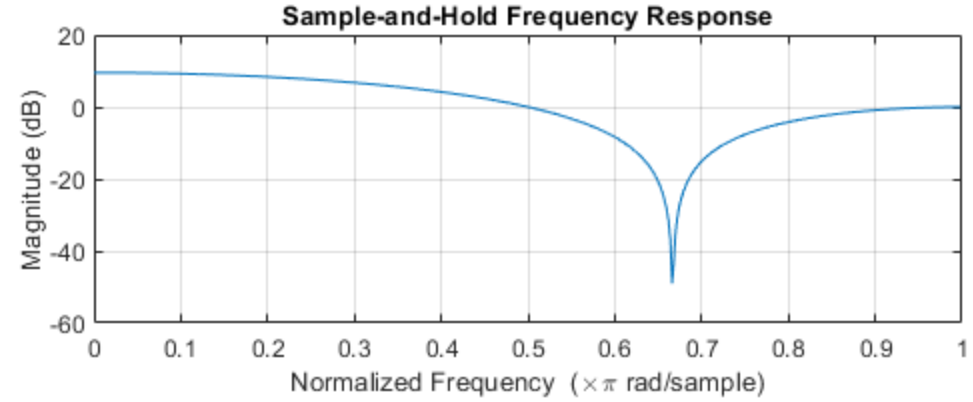


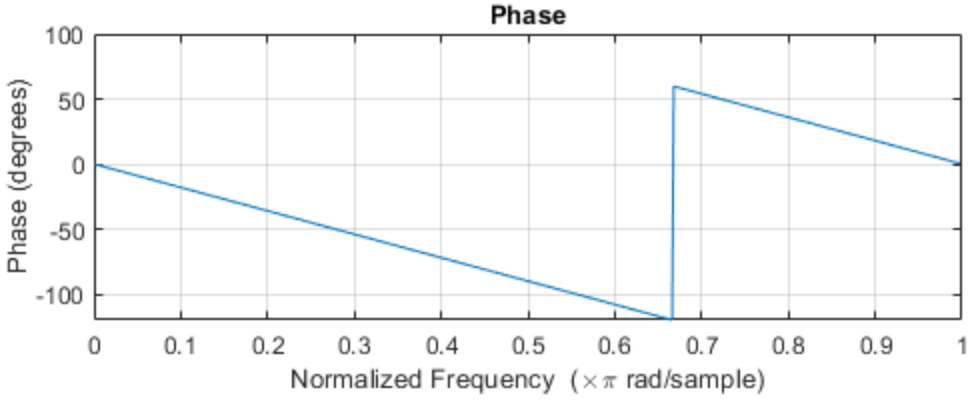
For 1D sampling rate conversion for x3 conversion, find the interpolation filters for sample-and-hold, linear interpolation, and cubic convolution interpolation (a=-0.5). Plot the impulse and magnitude responses of the filters.

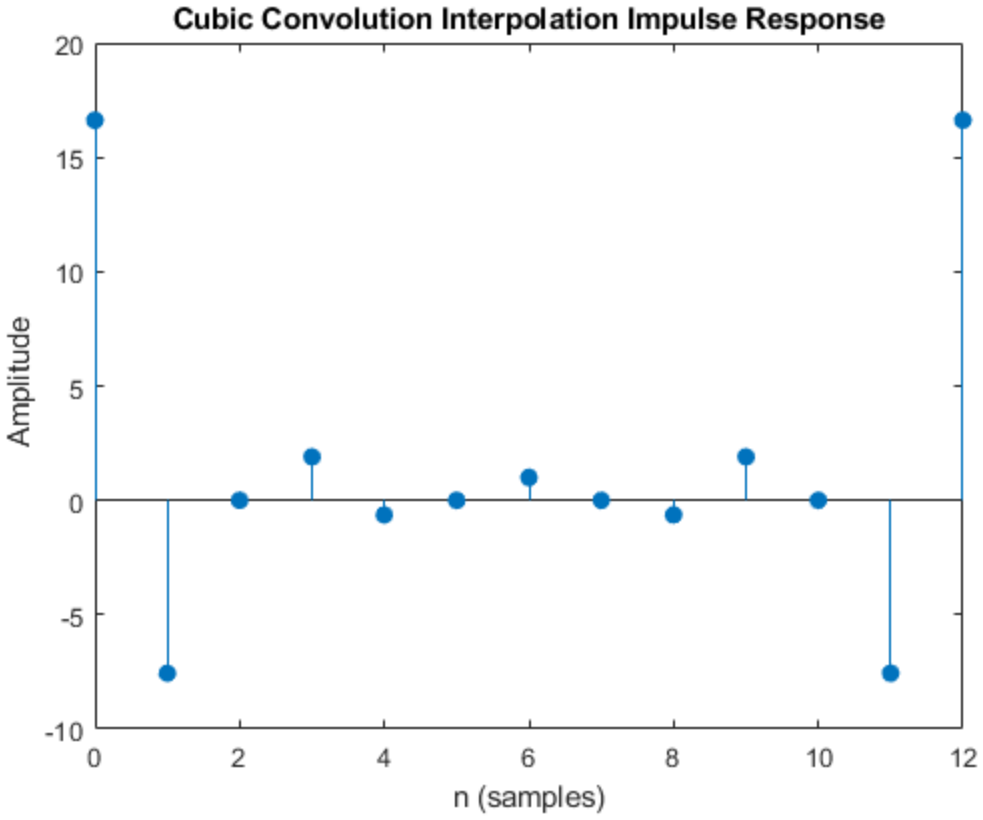

Linear Interpolation Impulse Response
Amplitude
n (samples)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
1
2
3
4
5
6

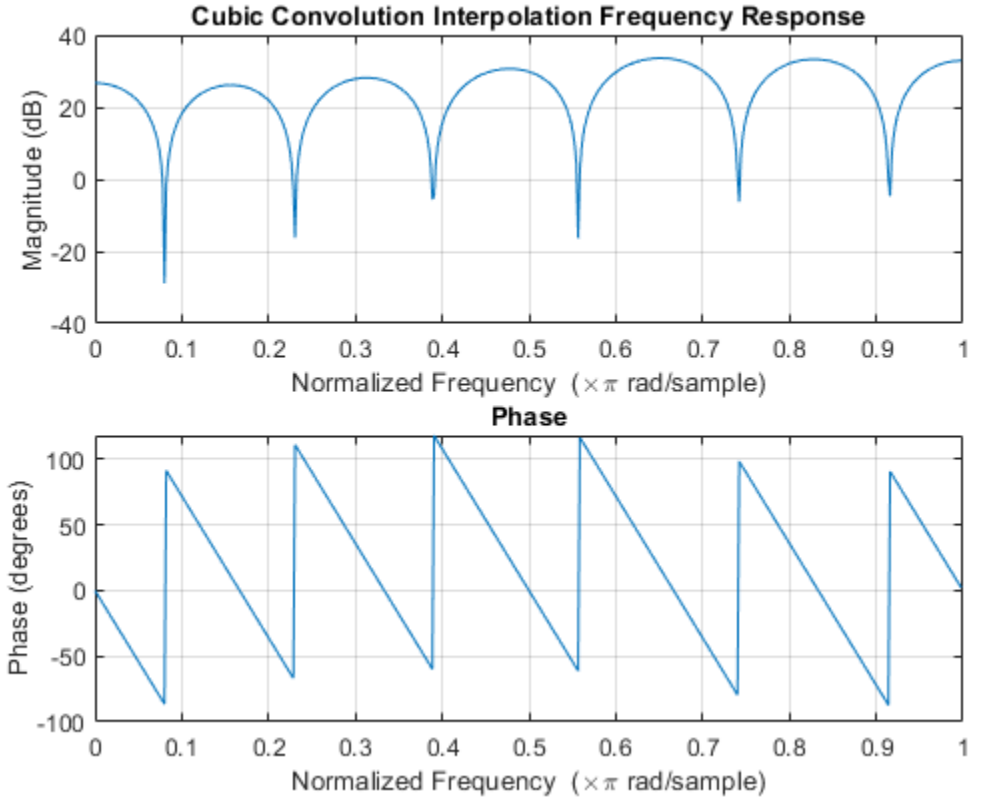

Linear Interpolation Frequency Response
Magnitude (dB)
Normalized Frequency (×π rad/sample)
20
0
-20
-40
-60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Phase
Phase (degrees)
Normalized Frequency (×π rad/sample)
0
-100
-200
-300
-400


Sample-and-Hold Impulse Response
Amplitude
n (samples)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


Sample-and-Hold Frequency Response
Magnitude (dB)
Normalized Frequency (×π rad/sample)
20
0
-20
-40
-60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

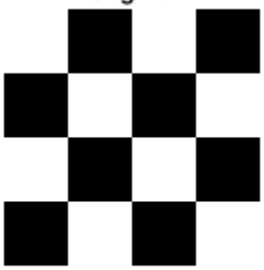

Phase
Phase (degrees)
Normalized Frequency (×π rad/sample)
100
50
0
-50
-100
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Cubic Convolution Interpolation Impulse Response
Amplitude
n (samples)
20
15
10
5
0
-5
-10
0
2
4
6
8
10
12

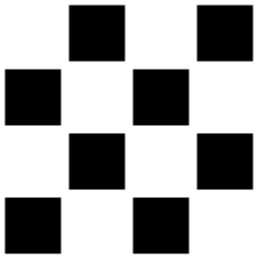

Cubic Convolution Interpolation Frequency Response
Magnitude (dB)
Normalized Frequency (×π rad/sample)
Phase
Phase (degrees)
Normalized Frequency (×π rad/sample)
40
20
0
-20
-40
100
50
0
-50
-100
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Using double for-loops, implement the filter by h=ones(5,5); (the center is the (0,0)th sample) with zero, repeated, and periodic boundary conditions. Show the original, filtered, and difference images. (The size of the filtered image is the same as the original.)

Original

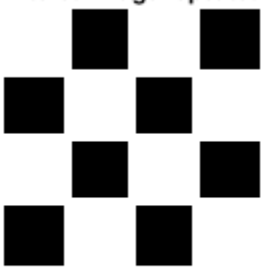


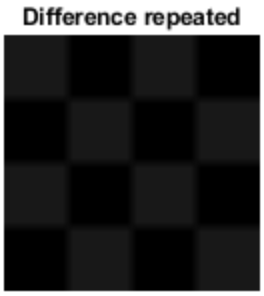
Filtered image periodic

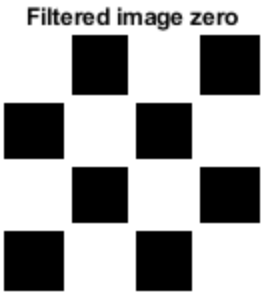


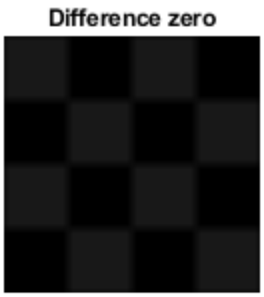
Difference periodic

Filtered image repeated





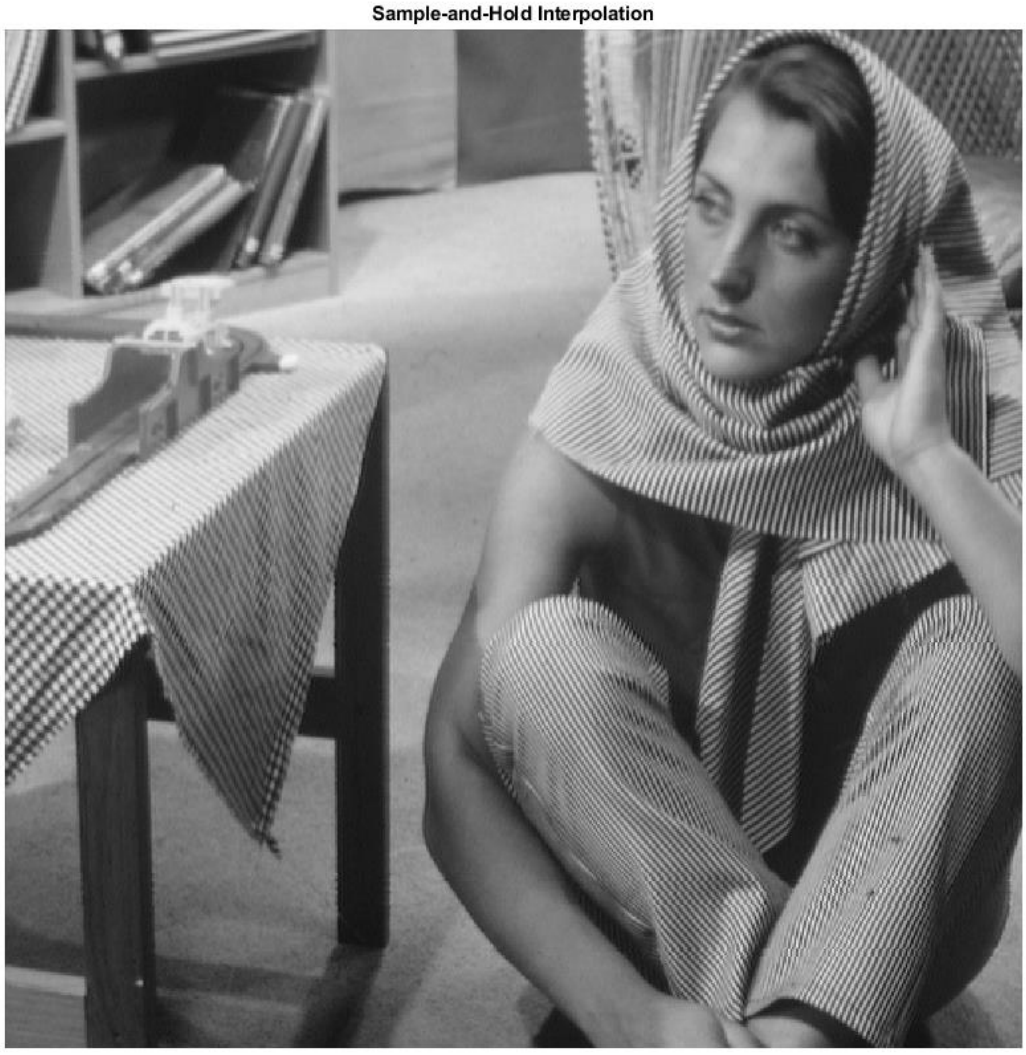




Scale the image by 3/2 by i) upsample the image by 3, ii) interpolate with a third band filter iii) anti-alias with a half band filter, iv) and downsample by 2. Display the result.

Cubic Convolution Interpolation

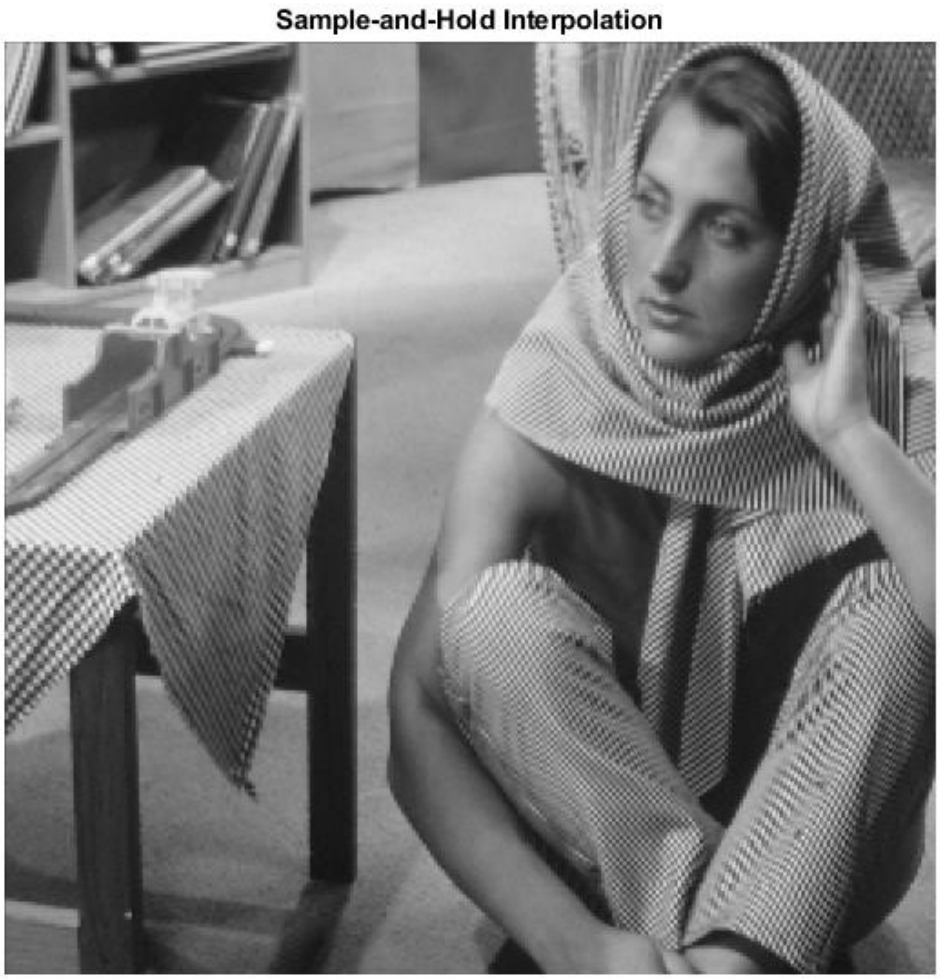
Linear Interpolation



Scale the result by 2/3 by i) upsample the image by 2, ii) interpolate with a half band filter, iii) anti-alias with a third band filter, iv) and downsample by 3. Display the result.

Cubic Convolution Interpolation

Linear Interpolation



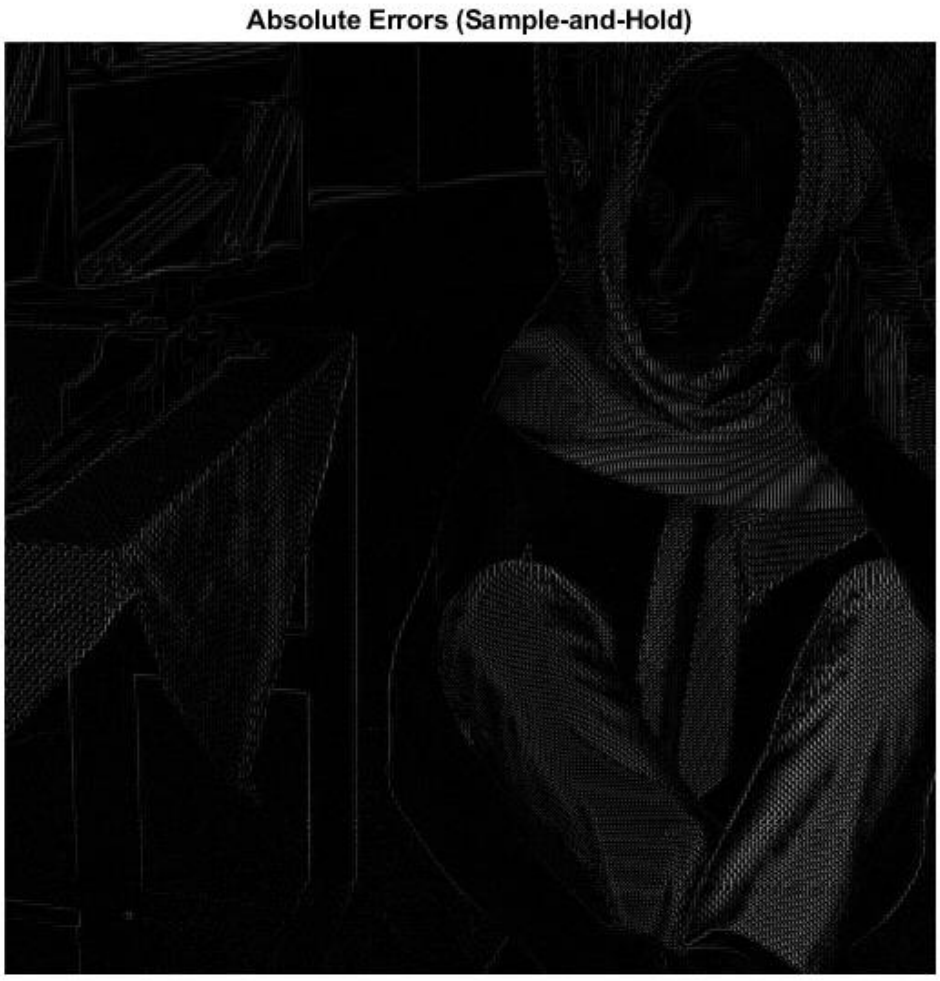
For sample-and-hold interpolation MSE is 0.004212.

For linear interpolation MSE is 0.003165.

For cubic interpolation MSE is 0.003376.

Absolute Errors (Cubic)

Absolute Errors (Linear)



Compare the demosaicing performance. We can check the absolute error between the demosaiced and original images, check if there are any demosaicing artifacts, and also measure the mean square error (MSE) between the demosaiced and original images.

MSE for cubic interpolation (step 2) is 0.000570 and for interpolated (step 3) is 0.000570.

Cubic interpolation

Absolute Errors (Cubic)

Interpolation filters

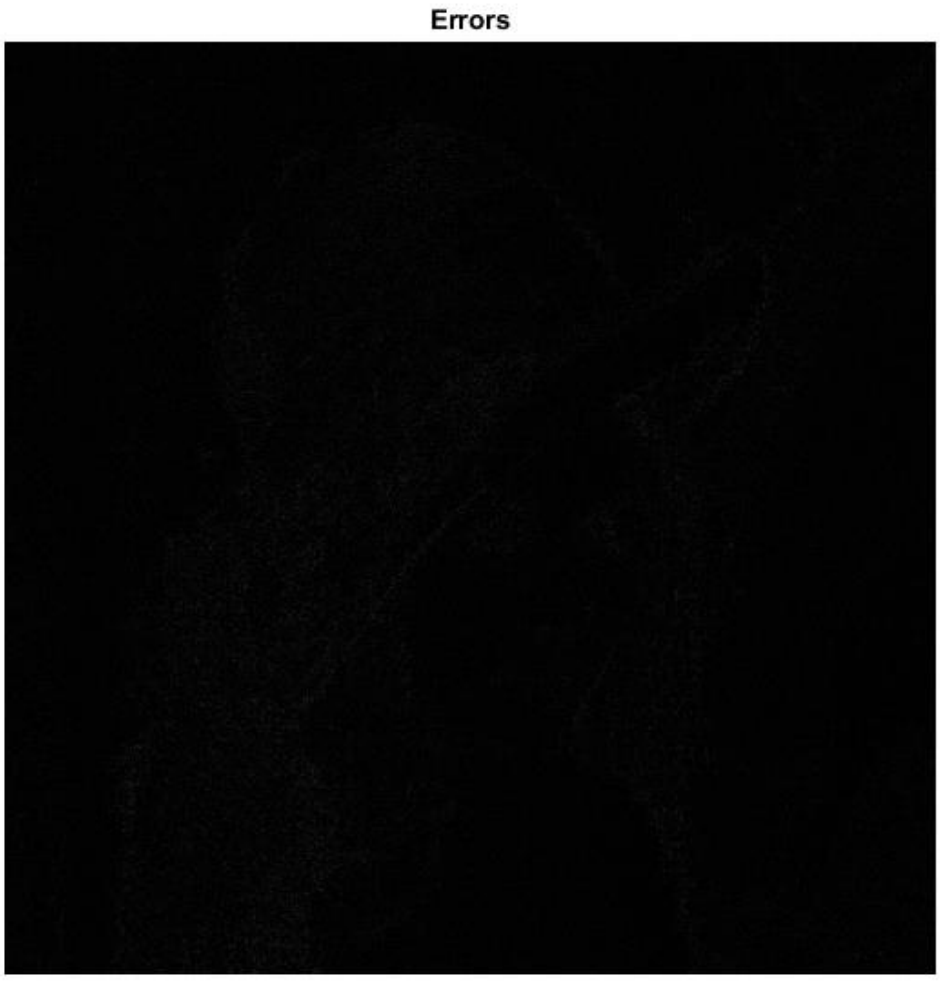
Absolute Errors (Interpolated)

Show the original, compressed, and (absolute) error images. Measure the MSE between the original and compressed images.

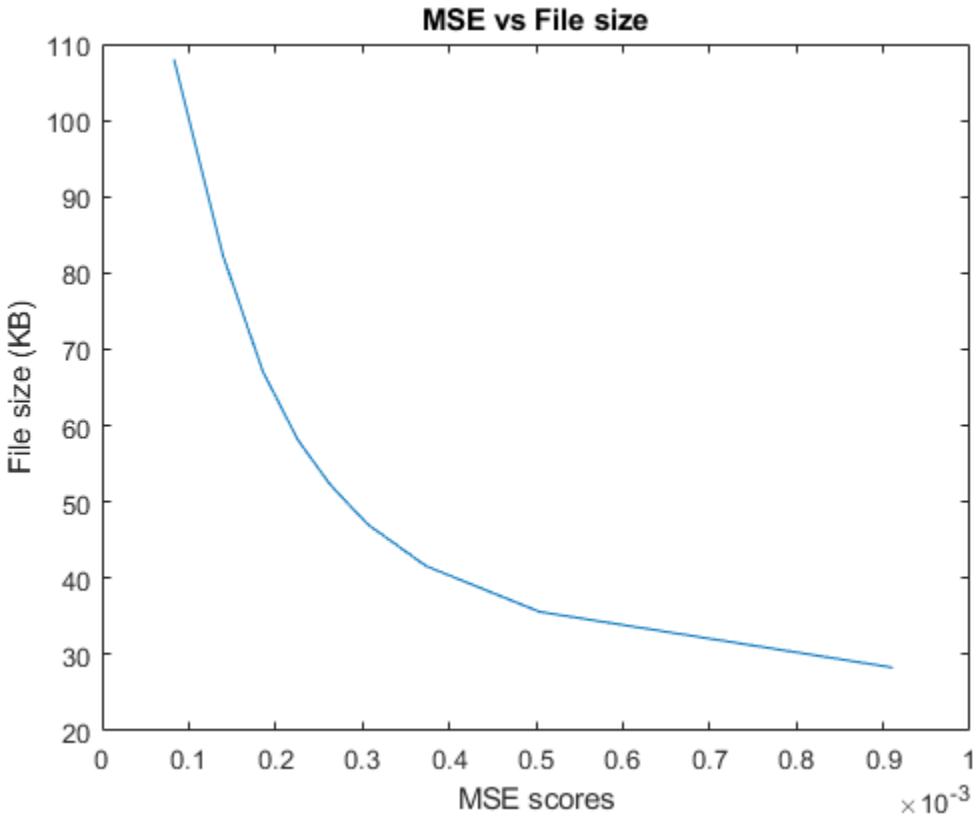
MSE score is 2.6260e-04.

Original

Compressed

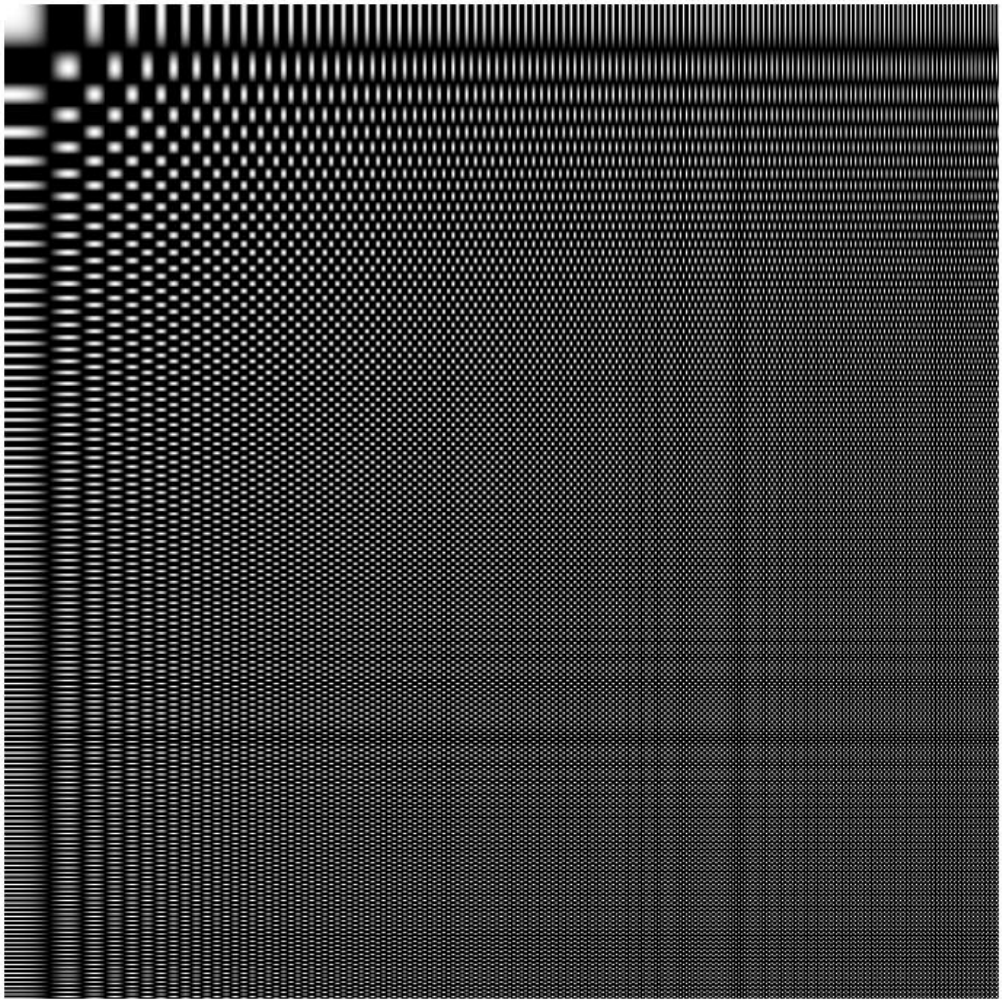


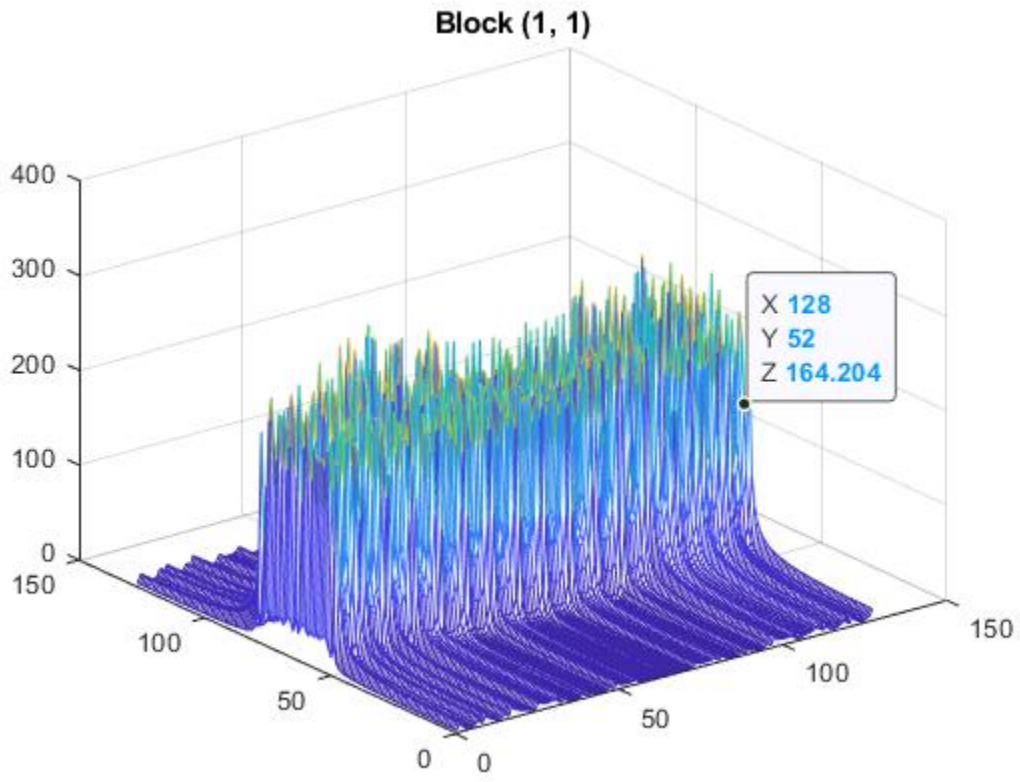
Collect the quantization results (indices, not quantized coefficients) of each block into a matrix b. Save it into a file by imwrite(abs(b),'comp_qf.tiff'). Measure MSE between the compressed and original images. Plot MSE vs file size.

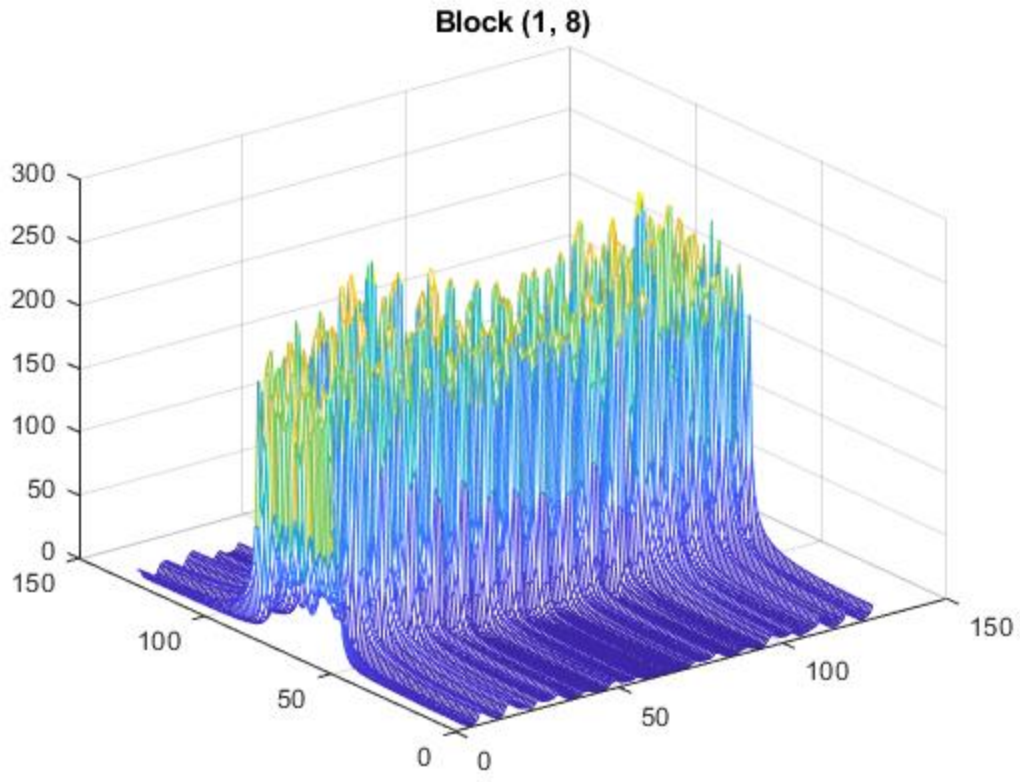


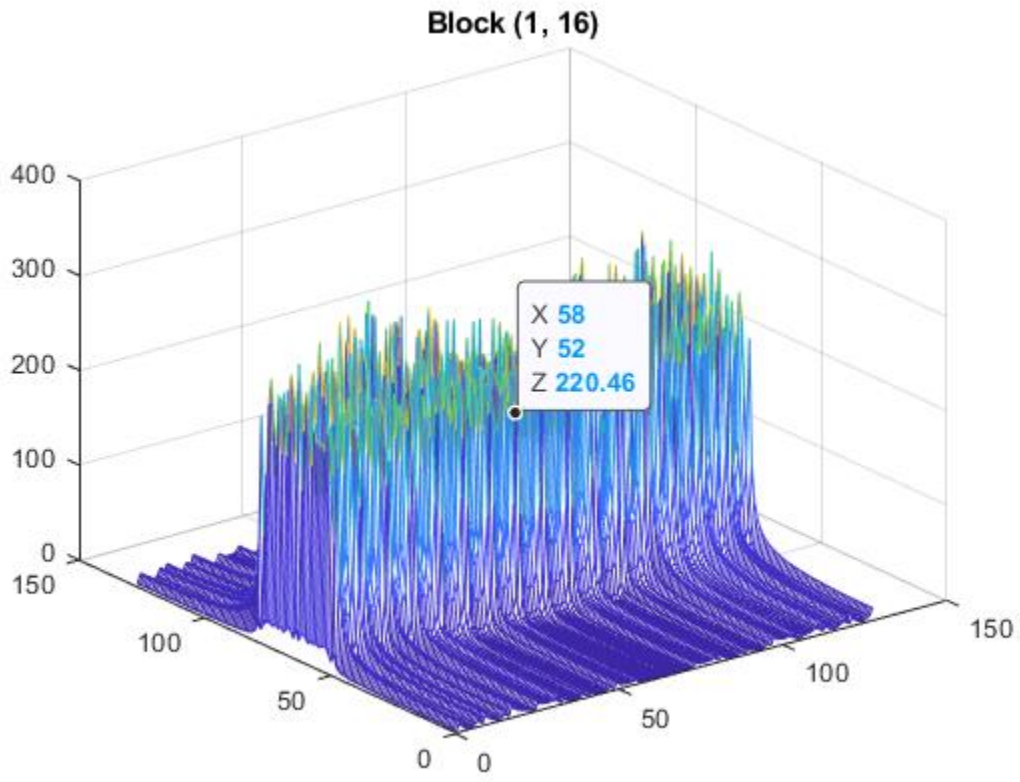
Download signal.mat, and show x. Apply 128 tap 2D fft to non-overlapping 128 ⇥ 128 sample blocks and plot the magnitude responses (absolute values of the 2D fft) using mesh.

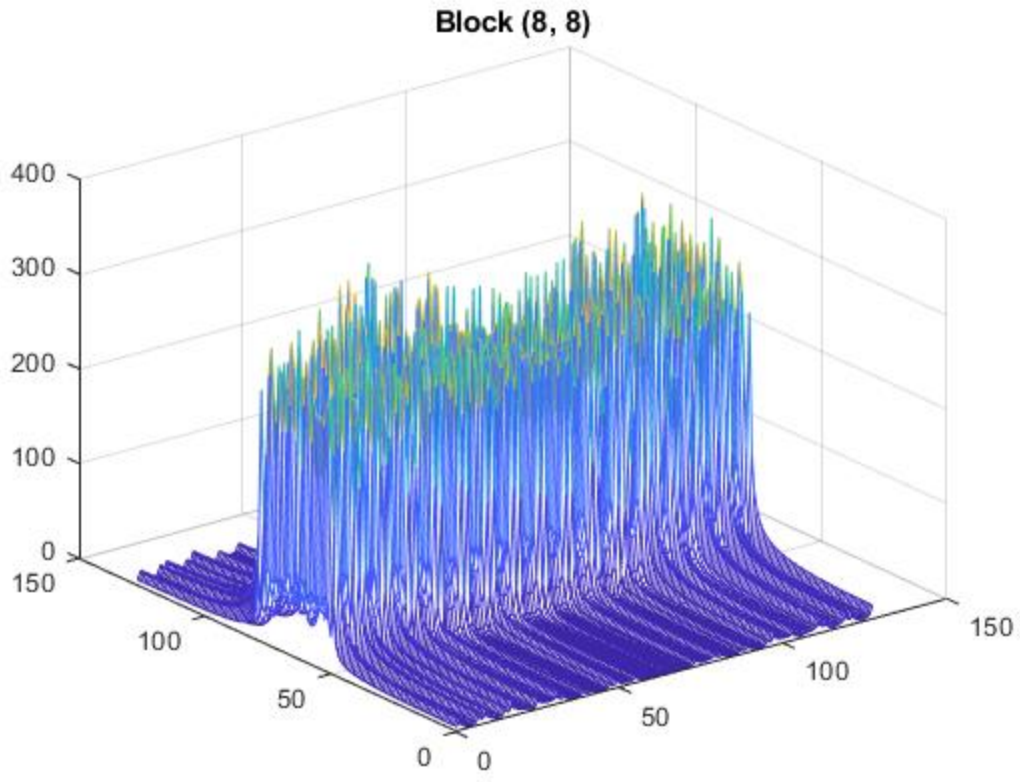
Signal

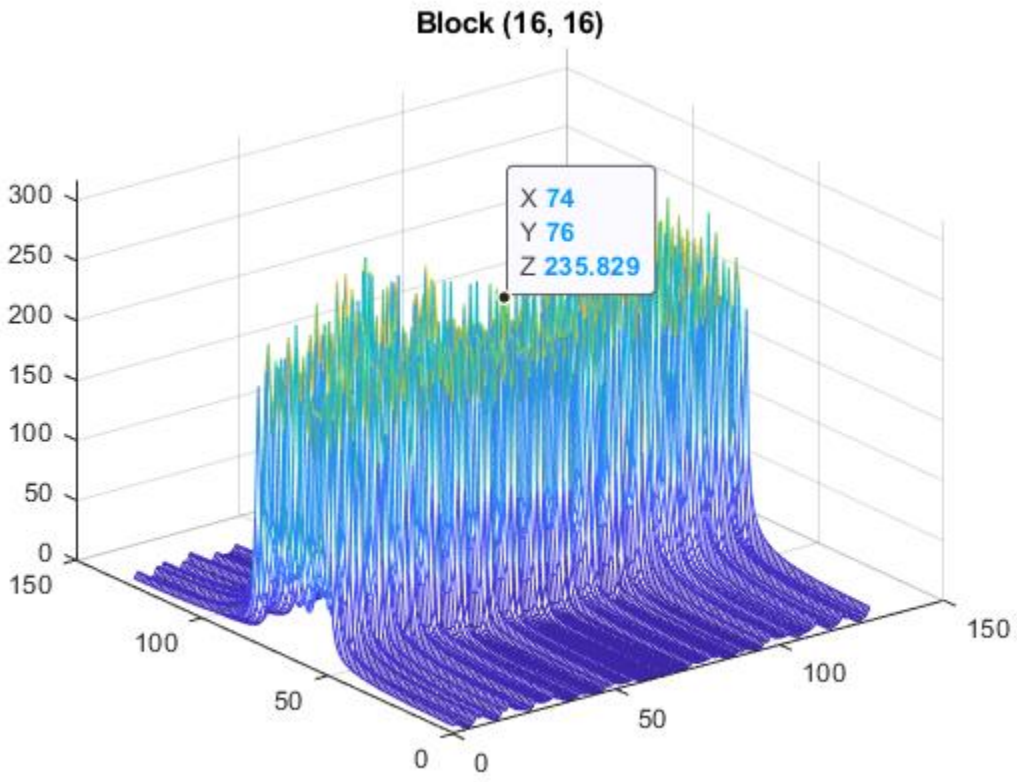



Block (1, 1)
400
300
200
100
0
150
100
50
0
0
50
100
150
X 128
Y 52
Z 164.204


Block (1, 8)
300
250
200
150
100
50
0
150
100
50
0
0
50
100
150


Block (1, 16)
400
300
200
100
0
150
100
50
0
0
50
100
150
X 58
Y 52
Z 220.46


Block (8, 8)
400
300
200
100
0
150
100
50
0
0
50
100
150


Block (16, 16)
X 74
Y 76
Z 235.829
300
250
200
150
100
50
0
150
100
50
0
0
50
100
150