ELL715
Assignment 4 Report

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1 Eagle

All images in this section are scaled by factor of 0.8

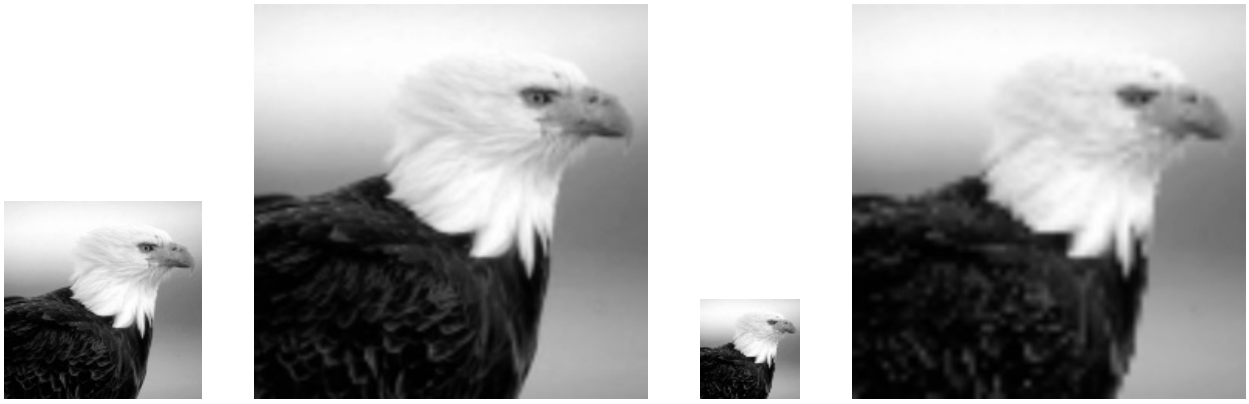
1.1 Original Image

Figure 1: Image Size: $256 * 256$

1.2 Part 1: Image Compression

1.2.1 Bilinear

- Scale x = scale y = 0.25
  - MSE = 27.75
  - Compression Ratio = 16
- Scale x = scale y = 0.5
  - MSE = 18.61
  - Compression Ratio = 4



(a) (b) (c) (d)

Figure 2: Compressed and uncompressed images for scale x = scale y = 0.5 and 0.25 respectively

1.2.2 Bicubic

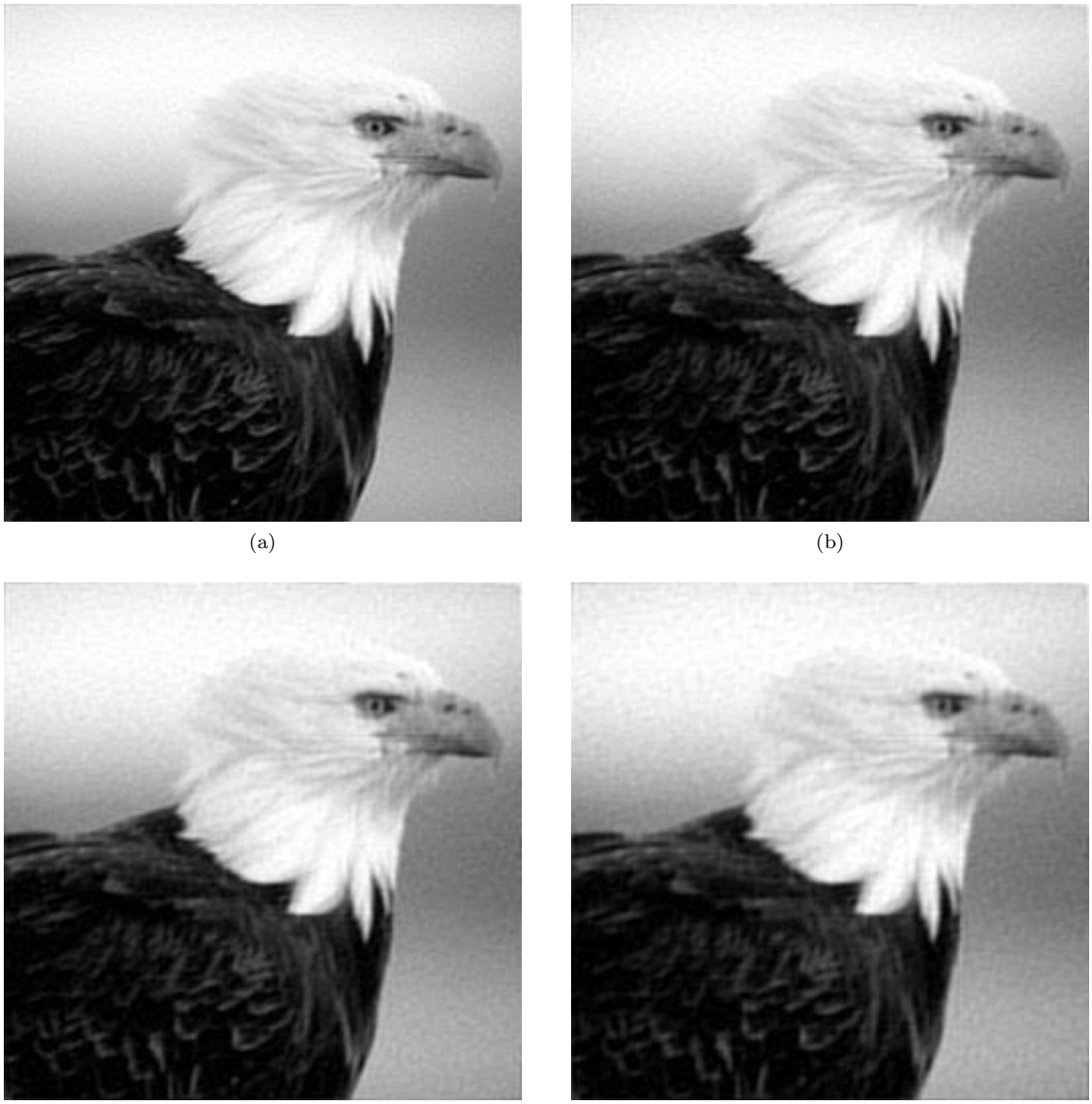
- Scale x = scale y = 0.25
  - MSE = 29.59
  - Compression Ratio = 16
- Scale x = scale y = 0.5
  - MSE = 15.00
  - Compression Ratio = 4

(a) (b) (c) (d)

Figure 3: Compressed and uncompressed images for scale x = scale y = 0.5 and 0.25 respectively

1.2.3 FFT

Following are the best four uncompressed images obtained by first compressing image using FFT and thresholding of coefficient and then decompressing using IFFT



(a) (b)

(c) (d)

Figure 4: The best four compressed images obtained using FFT compression

Image	Threshold	Compression ratio	MSE
a	3000	5.22	17.61
b	4000	7.25	27.28
c	5000	9.53	37.225
d	6000	12.11	47.419

1.2.4 DCT

Following are the best four uncompressed images obtained by taking idct of the compressed image

(a) (b)

(c) (d)

Figure 5: The best four compressed images obtained using DCT compression

Image	block size	max coefficient	Compression ratio	MSE
a	16	60	4.2	60.05
b	16	80	3.2	31.90
c	16	100	2.56	26.57
d	16	120	2.133	17.91

1.2.5 Observations

- Between Bilinear and Bicubic method we can see that bilinear method gives lower MSE for scale = 0.25 but larger for scale = 0.5 . and MSE of both the images are very close
- For same compression ratio (4) DCT is performing poorly than bilinear method
- FFT is giving the best compression ratio and best image
- So FFT compression is the best method for this image

1.3 Part 2: Seam Carving Method

(a)

(b)

(c)

(d)

(e)

(f)

Figure 6: Figures showing seam carved images

Image	Final Size	Compression ratio
a	(227 , 245)	1.18
b	(227 , 241)	1.20
c	(236 , 246)	1.13
d	(236 , 236)	1.176
e	(216 , 245)	1.24
f	(216 , 241)	1.25

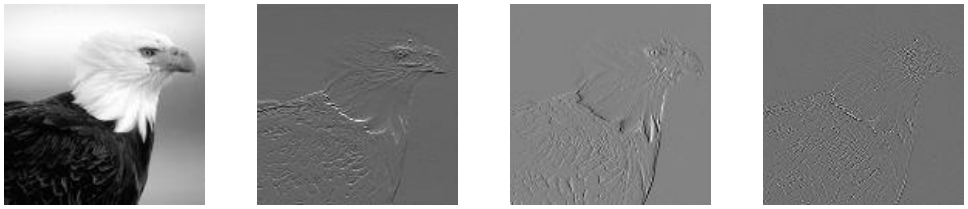
Figure 7: Image showing the first seam which would be removed by seam carving algorithm

1.3.1 Observations

- Best Compression is obtained for final image size 227 , 245, that is image a because it contains all the information of image
- On the right side of image energy calculated using sobel operator is less hence algorithm selected minimum energy seam there
- On trying to compress image more , we can see that image is loosing information (beak of eagle is getting cut)
- I have also implemented function to perform optimal selection between horizontal or vertical ordering but the results are coming almost the same to this method in which i removed first all the optimal horizontal and then vertical seam , so I have used latter method

1.4 Part 3: Wavelet Decomposition

1.4.1 First level images

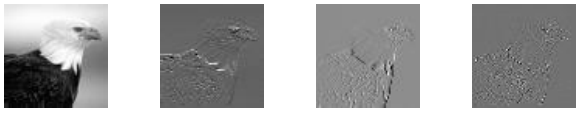


(a) LL (b) LH (c) HL (d) HH

Figure 8: First level decomposition corresponding to the eagle image

Figure 9: Reconstructed image using first level decomposition images

1.4.2 Second Level Images



(a) LL (b) LH (c) HL (d) HH

Figure 10: Second level decomposition corresponding to the eagle image (on LL component)

Figure 11: Reconstructed image using second level decomposition images (on LL component)

Figure 12: Reconstructed eagle image using LH, HL, HH in section 1.4.1 and the first level reconstructed image above

1.4.3 MSE

- The MSE for first case came out to be $2.852 * 10^{-27}$
- The MSE for second case came out to be $1.02 * 10^{-26}$
- MSE(1) < MSE(2), and this makes sense too, since we are using a first level reconstructed image (via second level decomposition) in second case to get the original image. In first case, we are using first level decomposition to get back original image, and hence lesser error.

2 Scenery Image

All the images in this section are scaled by factor of 0.25

2.1 Original Image

Figure 13: Image Size: $768 * 512$

2.2 Part 1: Image Compression

2.2.1 Bilinear

- Scale x = scale y = 0.25
  - MSE = 75.75
  - Compression Ratio = 16
- Scale x = scale y = 0.5
  - MSE = 65.17
  - Compression Ratio = 4

(a)

(b)

(c)

(d)

Figure 14: Compressed and uncompressed images for scale x = scale y = 0.5 and 0.25 respectively

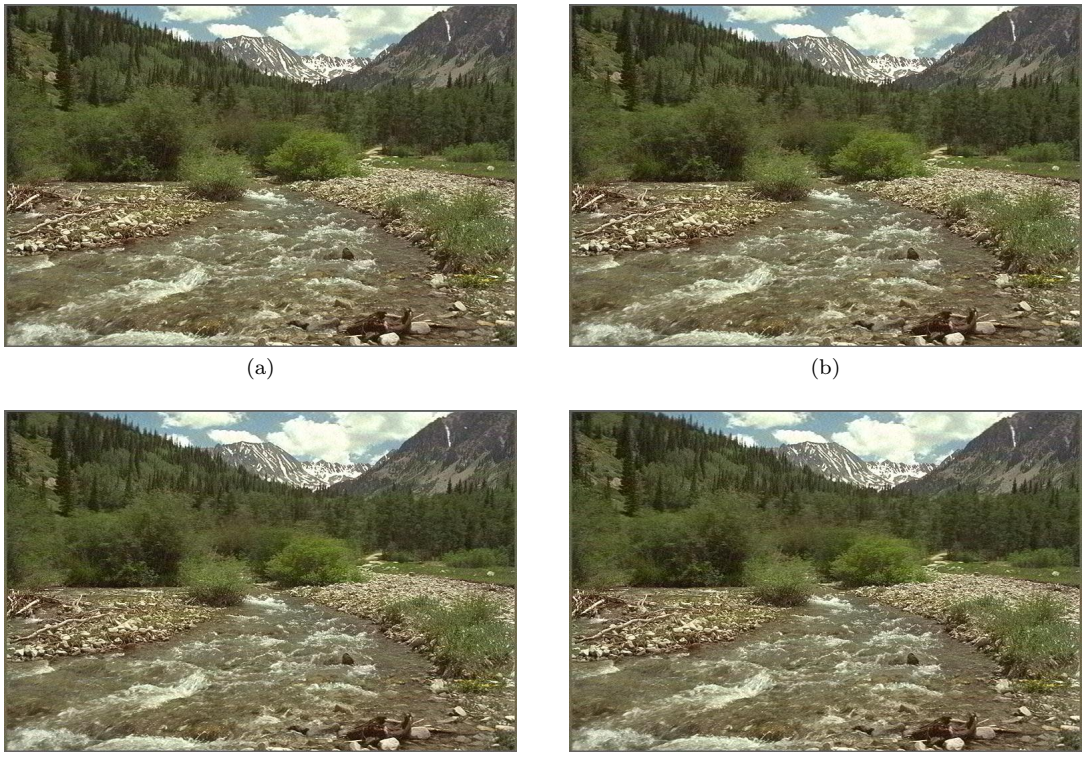
2.2.2 Bicubic

- Scale x = scale y = 0.25
  - MSE = 78.65
  - Compression Ratio = 16
- Scale x = scale y = 0.5
  - MSE = 62.97
  - Compression Ratio = 4

(a) (b) (c) (d)

Figure 15: Compressed and uncompressed images for scale x = scale y = 0.5 and 0.25 respectively

2.2.3 FFT



(a) (b)

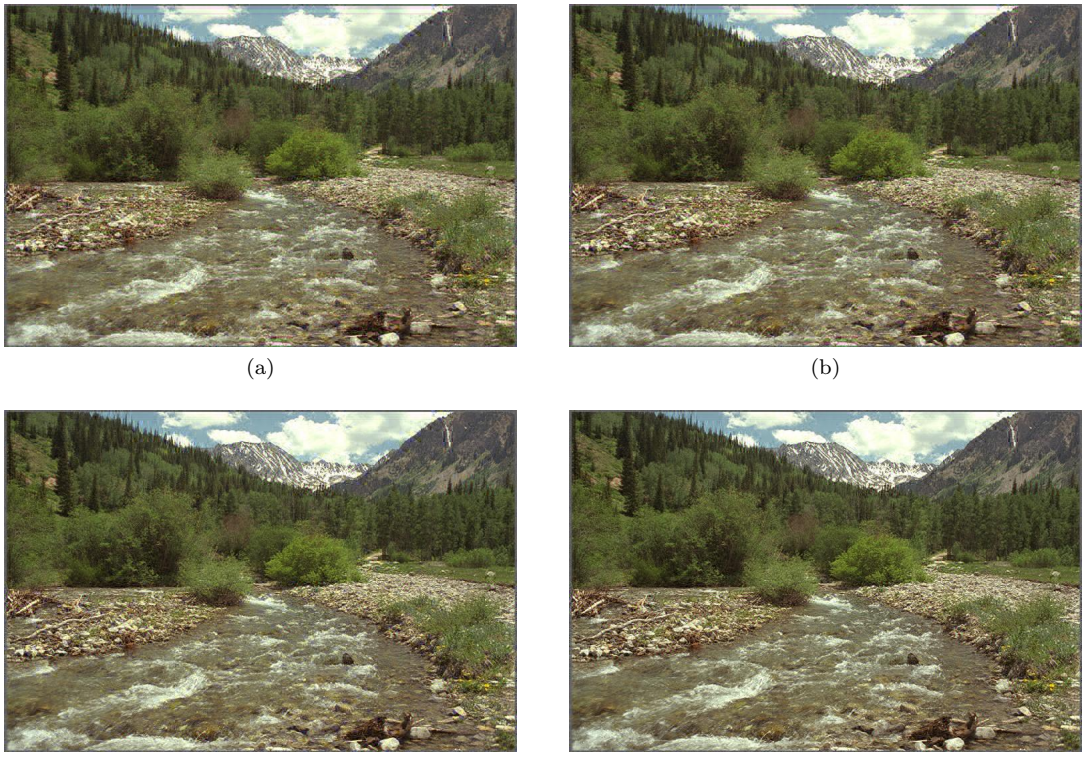
(c) (d)

Figure 16: The best four compressed images obtained using FFT compression

Image	Threshold	Compression ratio	MSE
a	1400	6.32	67.36
b	1500	6.77	76.92
c	1600	7.25	87.09
d	1700	7.74	97.41

2.2.4 DCT

Image	block size	max coefficient	Compression ratio	MSE
a	16	80	3.2	341
b	16	100	2.56	291.9
c	16	120	2.133	239.18
d	16	140	1.82	195.01



(a) (b)

(c) (d)

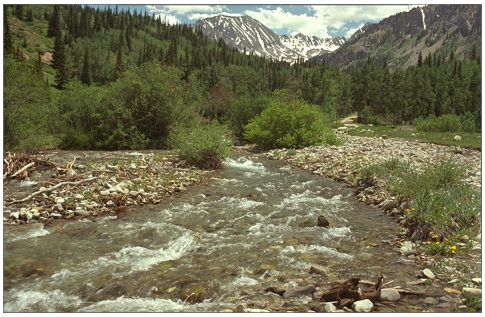
Figure 17: The best four compressed images obtained using DCT compression

2.2.5 Observations

- Between Bilinear and Bicubic method we can see that bilinear method gives lower MSE for scale = 0.25 but larger for scale = 0.5 . and MSE of both the images are very close
- For same compression ratio (4) DCT is performing poorly than bilinear method
- FFT is giving the best compression ratio and best image
- So FFT compression is the best method for this image

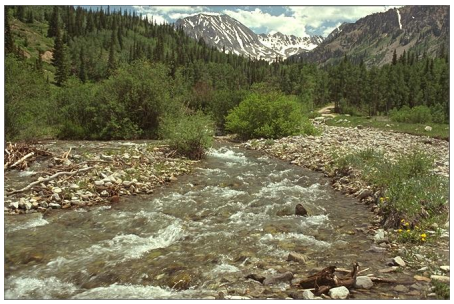
2.3 Part 2: Seam Carving Method

Image	Final Size	Compression ratio
a	(462, 718, 3)	1.185
b	(452 , 708, 3)	1.23
c	(442 , 668, 3)	1.33
d	(382 , 638 , 3)	1.61



(a)

(b)



(c)

(d)

Figure 18: Compressed images using seam carving method

2.3.1 Observations

- We can see that image is not loosing much information even though we have decreased the size of image by 100 pixels in both dimensions . Hence image of size (442,668,3) is the best compressed image
- Seam carving algorithm is able to perform better in this case because there is not much information in low energy seams
- Best compression is obtained for image size : (382,638,3) .

2.3.2 Challenges

Sometimes it may happen that the low energy seam contains most useful information in the image (Like a face) and if we will use same algorithm without modification than we will loose that information , so to prevent that we can increase the weight (energy) of that important part manually in the image . But still if we have lots of image than identifying the most important parts of image may become cumbersome , so retaining most important part of the image is challenge to this algorithm

3 References

- https://www.math.cuhk.edu.hk/ lmlui/dct.pdf
- https://en.wikipedia.org/wiki/Infinite_impulse_response
- https://homepages.inf.ed.ac.uk/rbf/HIPR2/fourier.htm