CS 6476: Computer Vision, Fall 2019

PS1

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1A Short answer problems: Using Matlab

1.Give an example of how one can exploit the associative property of convolution to more efficiently filter an image.
Ans. The associative property of convolution states that given images a, b and c, (a*b)*c = a*(b*c). It allows multiple filters to be merged into a single filter that can then be used on the image. This is useful when using multiple filters on multiple images. In this situation, multiple filters can be merged into one and then applied on images. For example, applying a derivative filter (to display edges) and then applying a Gaussian filter (for smoothening) is the same as implementing the derivative of Gaussian filter on the image.

d/dx(h*f) = (d/dx h)*f, where h is the Gaussian filter and f is the image.

2. This is the input image: [0 0 1 1 0 0 1 1]. What is the result of dilation with a structuring element [1 1 1]?
Ans. [0 1 1 1 1 1 1 1]

3. The filter f' = [0 -1/2 0 1/2 0] is used as the filter to compute an estimate of the first derivative of the image in the x direction. What is the corresponding second derivative filter f". (Hint: Assymetric filters must be flipped prior to convolution.)
Ans. $f'' = f'^T * [1\ 0\ -1] = \begin{bmatrix} 0 & 0 & 0 \\ -1/2 & 0 & 1/2 \\ 0 & 0 & 0 \\ 1/2 & 0 & -1/2 \\ 0 & 0 & 0 \end{bmatrix}$

4. Name two specific ways in which one could reduce the amount of fine, detailed edges that are detected with the Canny edge detector.
Ans. Hysteresis Thresholding and Non-maximum suppression

5. Describe a possible flaw in the use of additive Gaussian noise to represent image noise.
Ans. Additive Gaussian noise does not account for various other types of image noise such as salt & pepper noise, shot noise, periodic noise, quantization noise etc. While denoising such an image, it may not denoise the effects of noise from other such filters. Hence, it's sometimes flawed.

There's also a possibility of removing finer details of the image while denoising using smoothening filters such as Gaussian and Median filters.

6. Design a method that takes video data from a camera perched above a conveyor belt at an automotive equipment manufacturer, and reports any flaws in the assembly of a part. Your response should be a list of concise, specific steps, and should incorporate several techniques covered in class thus far. Specify any important assumptions your method makes.
Ans. Assume that the system has a set of images of the automotive equipment with no flaws. Assume that the equipment are placed in the same position and under similar lighting conditions as that in the images.
Steps:

1. Extract video data from camera to system.
2. Extract image of the centered equipment from the video.
3. Extract image of equipment using background removal.
4. Apply denoising filters such as Gaussian or median filter.

5. Extract color histogram and match it with the image stored in database. If they aren't similar, error is detected.
6. Extract edges and then convert to binary image
7. Dilate, then erode the image to remove noise in the form of spurious holes in the foreground.
8. Identify distinct regions and label them.
9. Compute the difference in original image in database and the image extracted from video data.
10. Extract largest region from the resulting image.
11. If resulting image has an area above a certain threshold, defect detected. Return the label of the part where the error is detected as well.
12. Texture analysis by extracted region. Match the filter response of various extracted regions to their corresponding regions in the image from database. Error detected if the difference in result is higher than a threshold.
13. If no error detected, move to next equipment.

2Programming Problem: Content-aware Image Resizing

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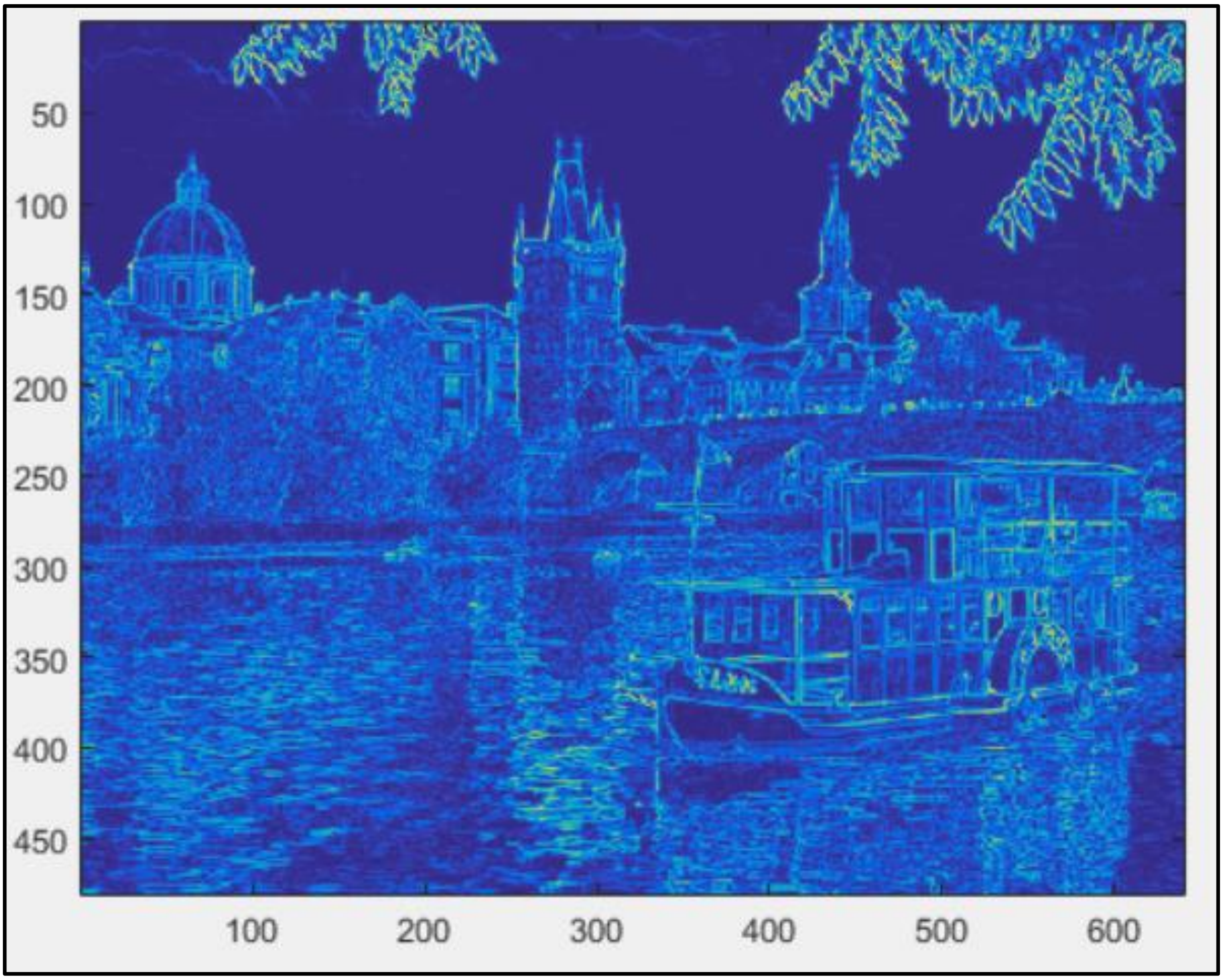
2

3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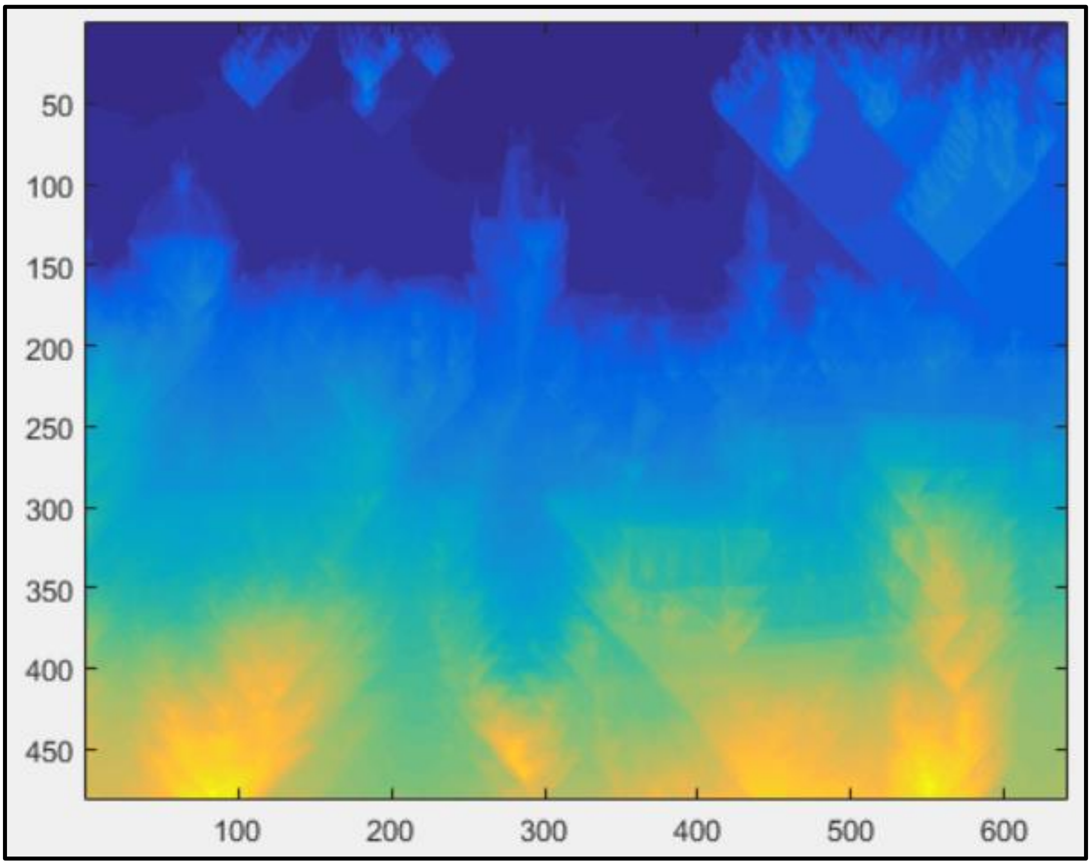
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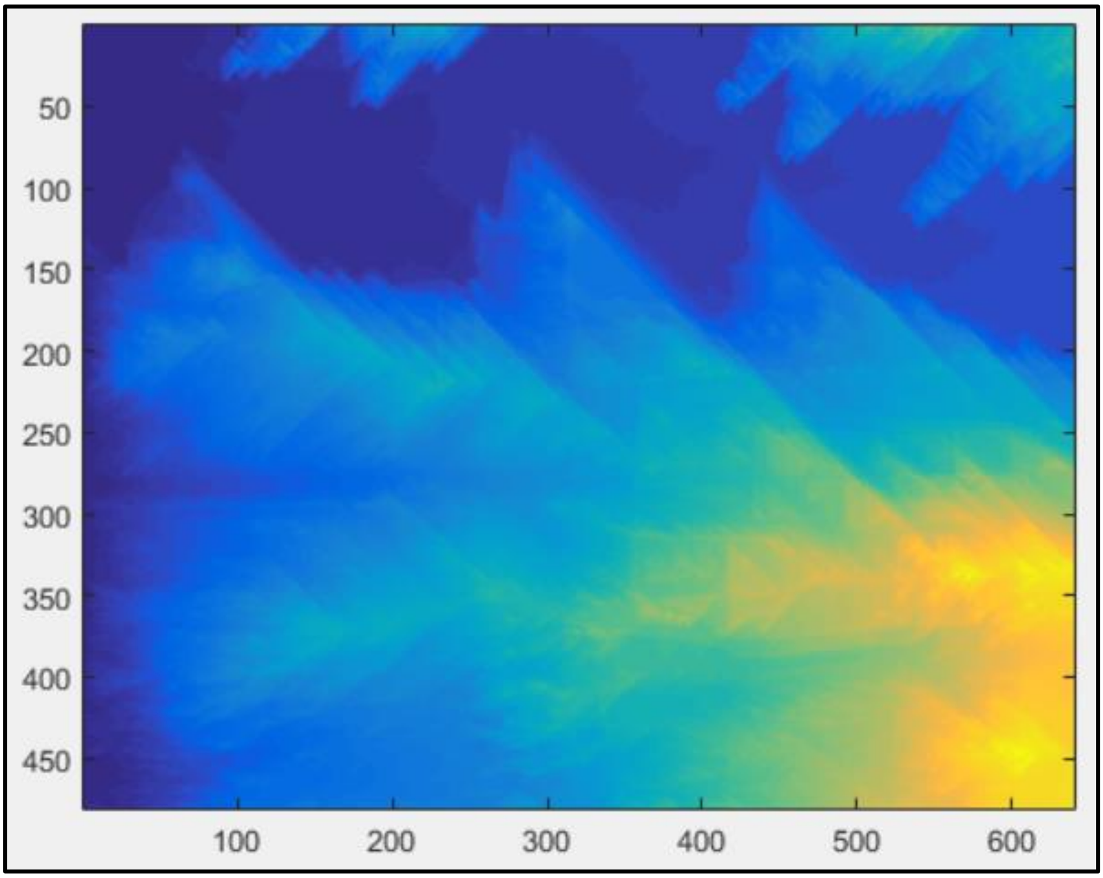


The second figure shows the cumulative energy map for seams in the vertical direction. The yellowish regions indicate regions of high energy, that is, regions which contain greater detail or gradient. Bluish colours denote regions with the least gradient. Superimposing this colormap on the image of Prague, we find that the region having water shows the highest energy because of fine ripples (details). Of medium energy are regions that contain buildings. The sky, which has minimal variations, shows the least energy, i.e a blue hue.

The third figure shows the cumulative energy map for seams in the horizontal direction. The boat has vertical structures that provide maximum gradient in the horizontal direction. Hence that region of the image shows high energy. The buildings, owing to their vertical structures, show medium energy in the map. The sky, once again, having minimal variation, shows the least energy.

4. As seen from the cumulative energy maps above, for vertical seams, the bottom-most row shows the lowest energy around the region having column value 200. On the image, we can see that the vertical seam originates from that region. Thus making it the seam most likely to have the least energy.

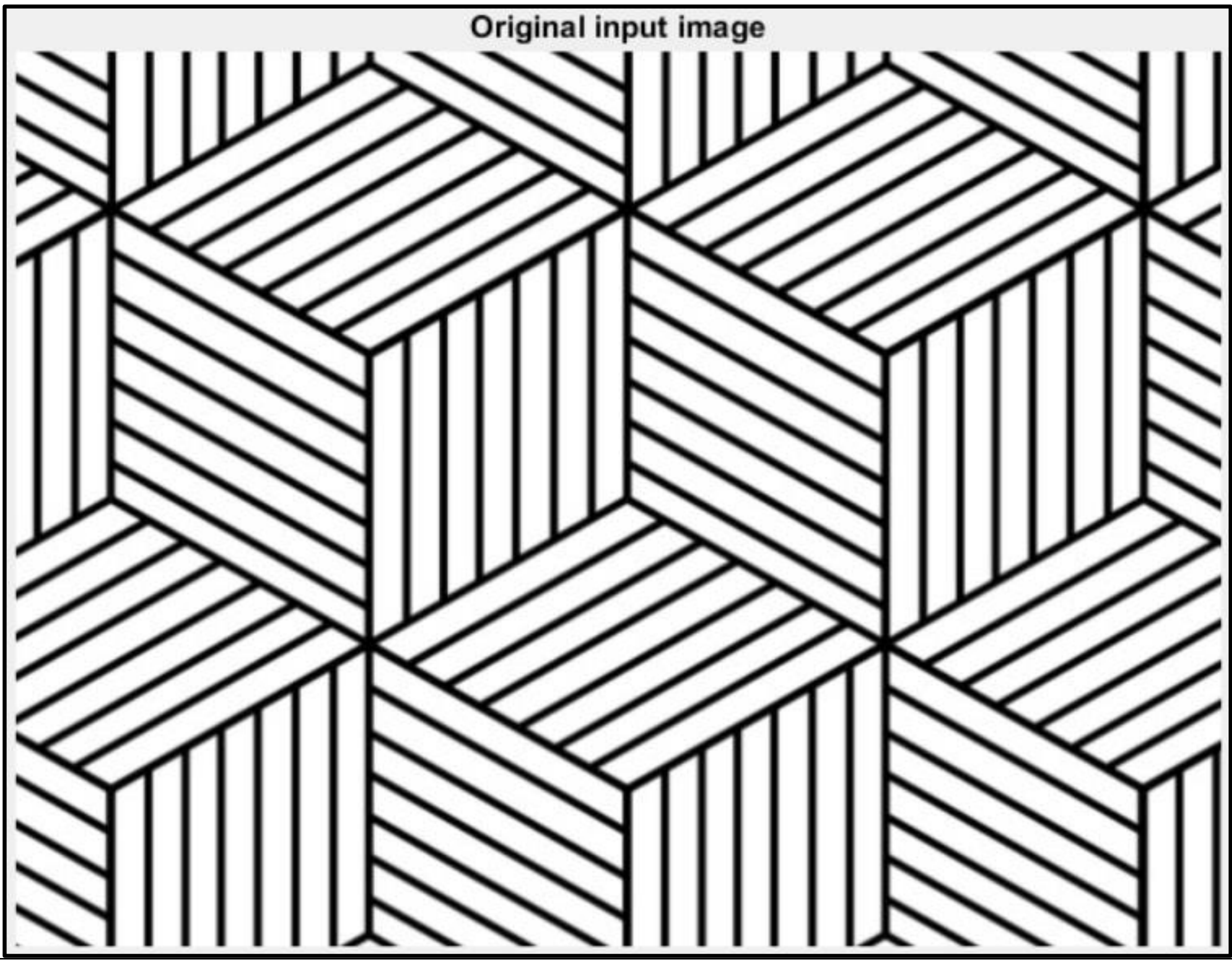
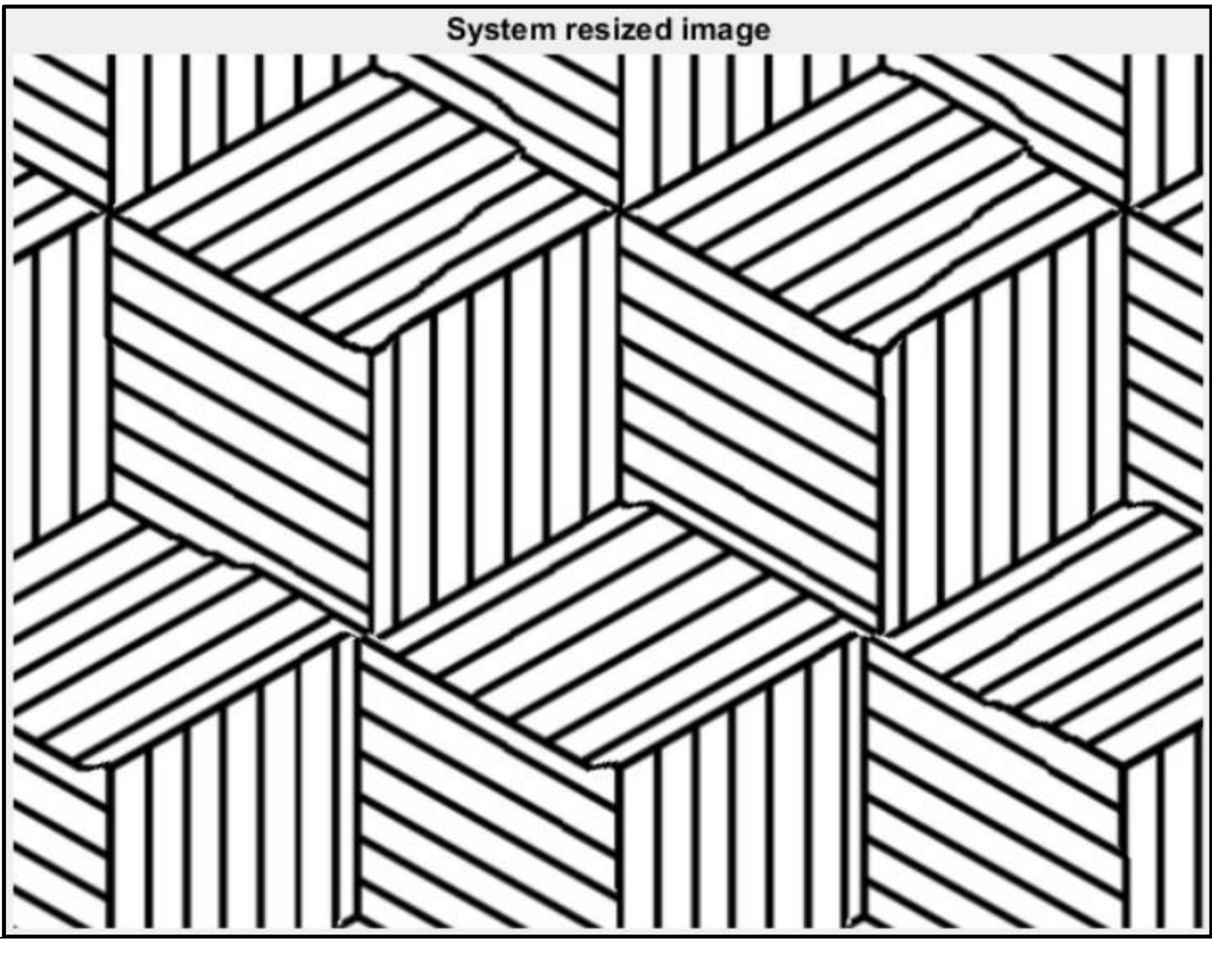
On the other hand, in the energy map for horizontal seam, on the right-most row, the lowest energy region occurs around row value 150. On the original image, we see a horizontal seam originating from there. This makes the seam to be least likely to have the least energy value. For the above reasons, we see that the seams chosen are optimum.

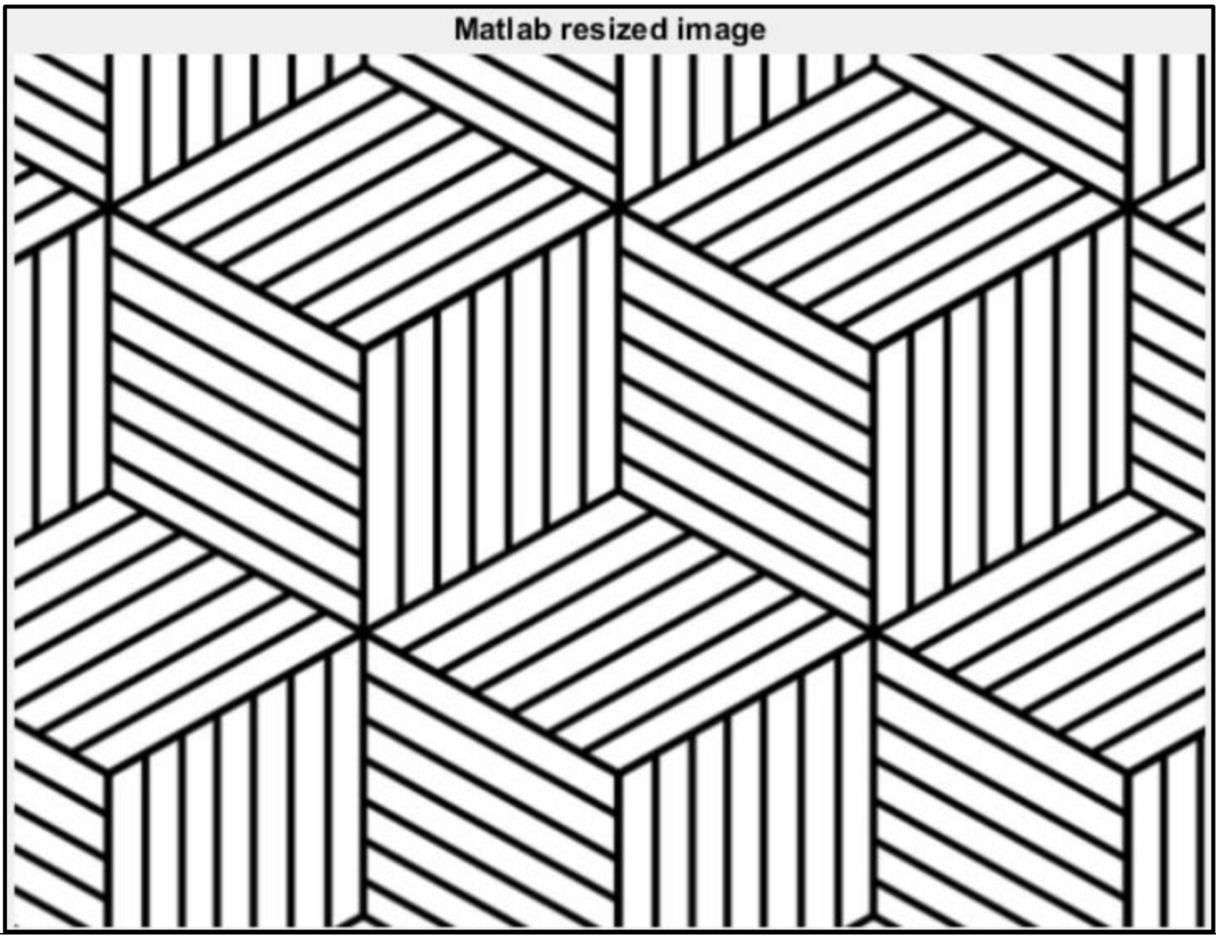

ELBIS

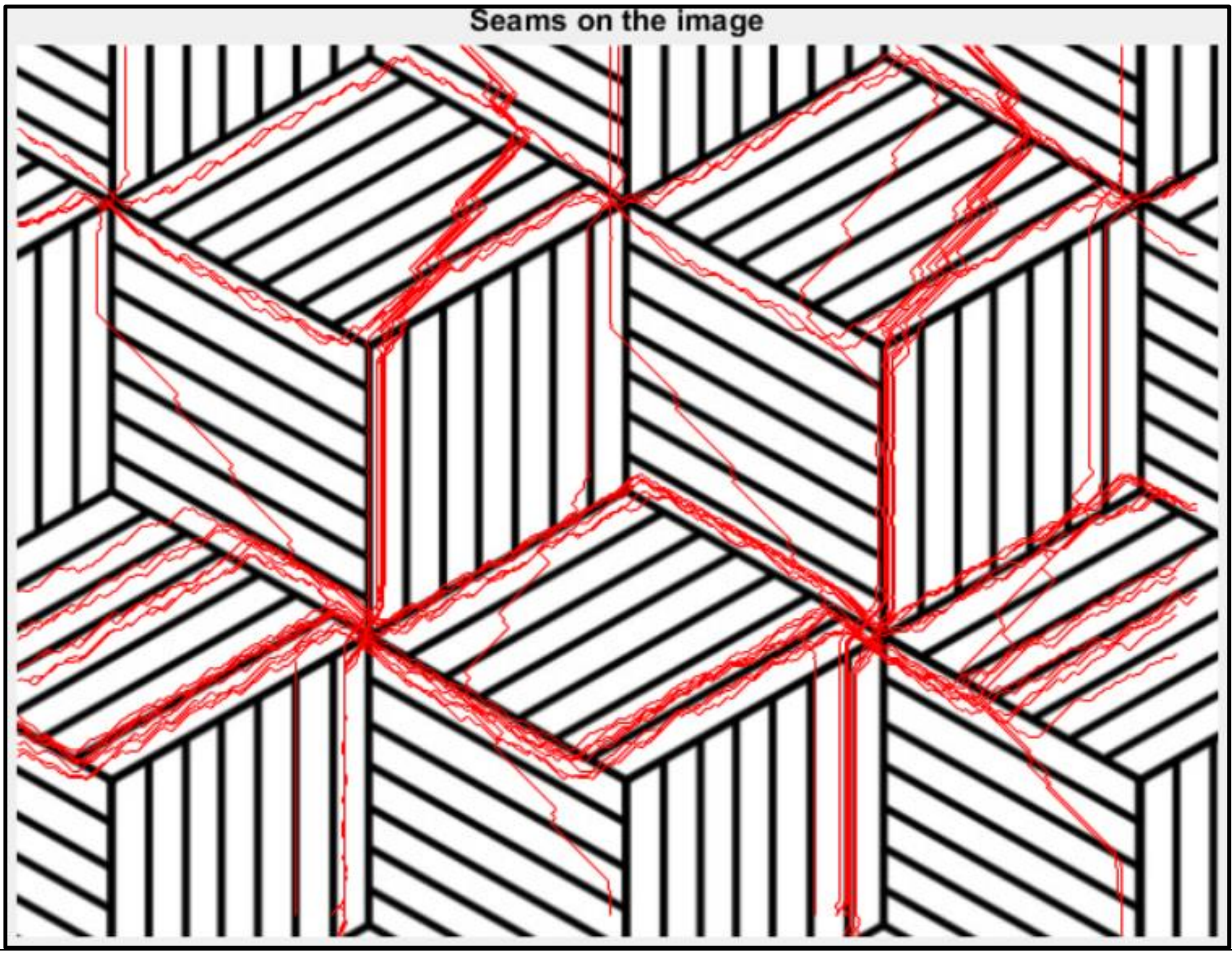
5.

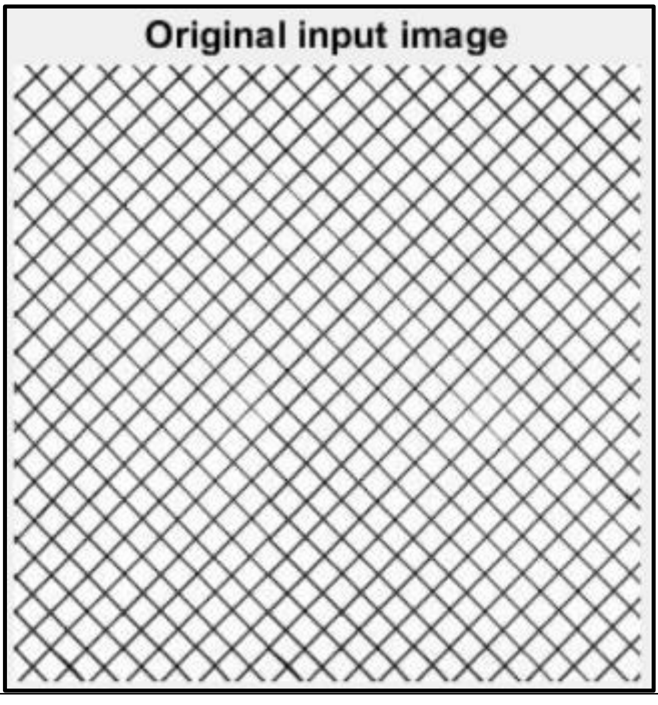
The above image has been subjected to calculation of energy function given in the Seam carving for content-aware image resizing paper. As opposed to this one, the below image has been subjected to an energy function that makes use of intermediate difference gradient. The difference in the resized images can be noticed along the edges of the buildings. The second resized image has a slanted edge of a building.

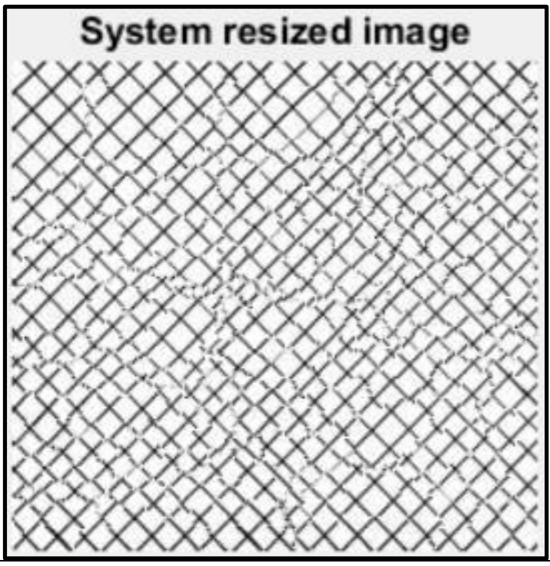
Resized Image

6. (a)	
(b)	

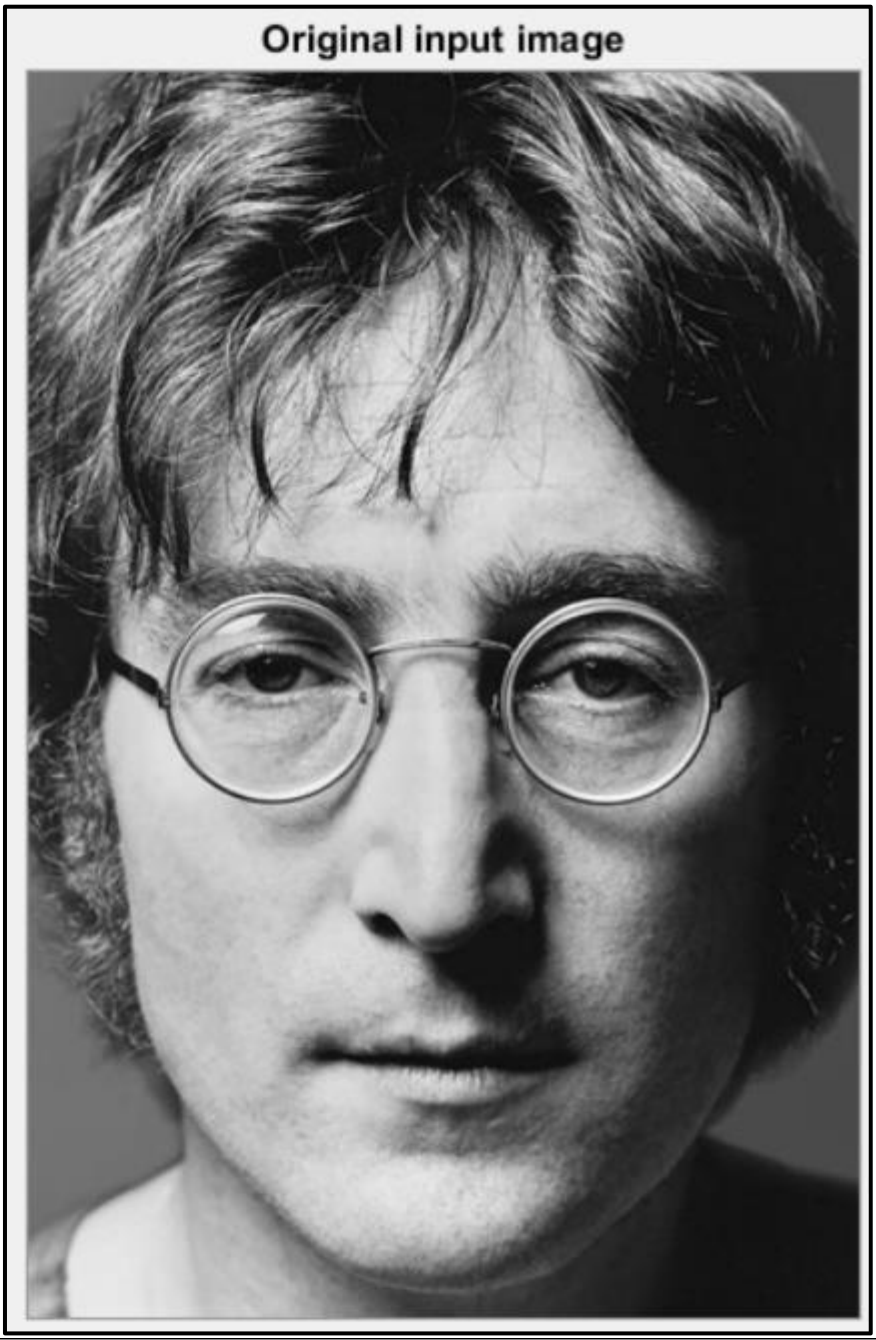
(c)	
(d)	Input size: 592x440. Output size: 572x420.
(e)	V-10, H-10, V-10, H-10

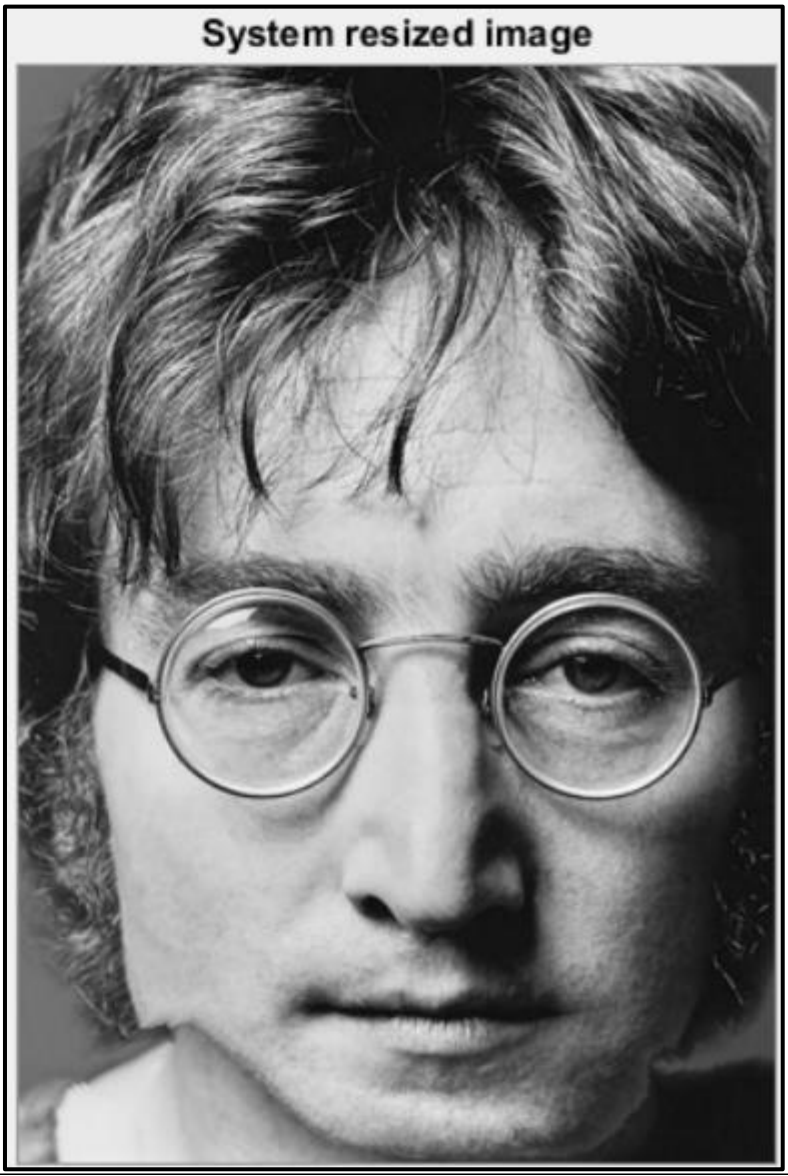
	
(f)	Seams come up along the path of least energy, which are the black lines. When these seams are removed, they leave the straight edges disfigured, resulting in the crooked lines of the pattern.

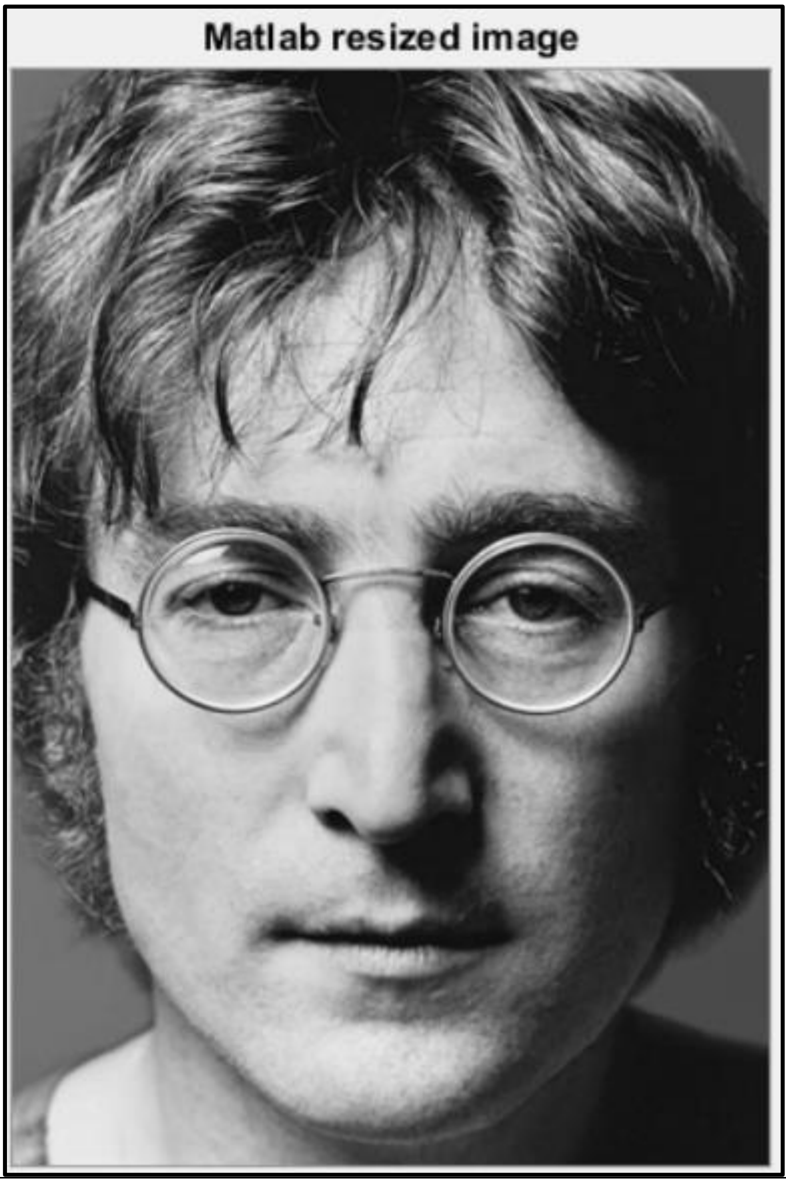
(a)	

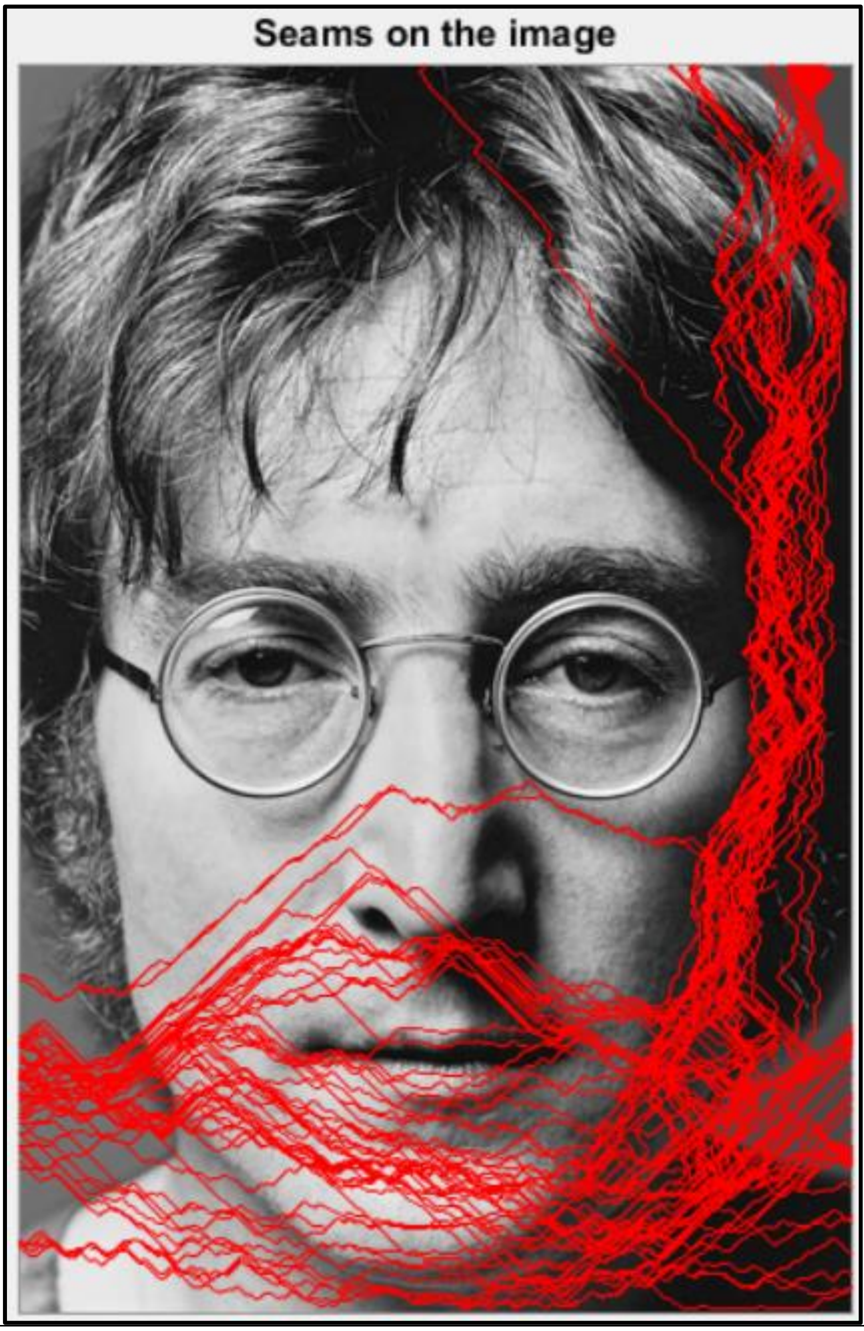
(b)	
(c)	
(d)	Input size: 250x246. Output size: 210x196.
(e)	V-30, H-20, V- 10, H-30 

(f)	Seams come up along the path of least energy, which are the black lines. When these seams are removed, they leave the straight edges disfigured, resulting in the crooked lines of the pattern.

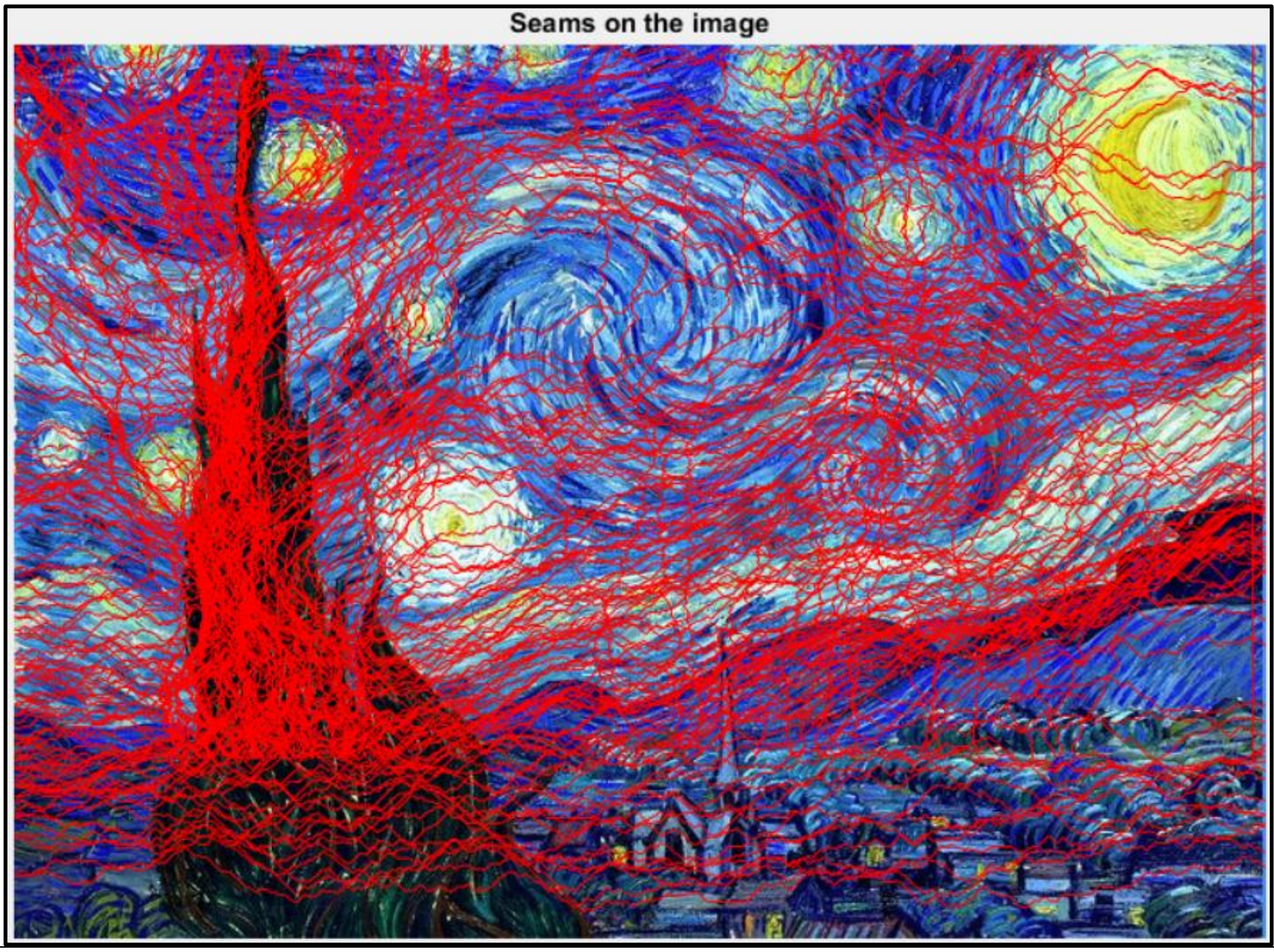
(a)	

(b)	

(c)	
(d)	Input size: 334x500. Output size: 304x440
(e)	H-50, V-10, V-20, H-10

	
(f)	This photo of John Lennon has seams along the shadow regions of his face. Surely, these regions have less intensity variations than the lighted regions of the face. Hence, after seam carving, the image contains lighter shades of the face. Also, this is responsible for the disproportionate resizing of the face.

(a)	
(b)	

(c)	
(d)	Input size: 700x500. Output size: 600x380
(e)	H-100, V-100, H-20 
(f)	Seams tend to gather around the dark pixels and the dark patch as it contains the least amount of energy. During resizing, most of the black patch gets eliminated. Horizontal seams run along the painted bands of the

	sky in the painting. When these seams get eliminated, the bands get narrower, thereby preserving the shape of the moon and stars.