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Short answer problems [24 points]

Que1.
Given an example of how one can exploit the associative property of convolution to more efficiently filter an image.

Solution1.
Example: suppose there are two filters f,h and which has to be applied on an image g
In this case by the associative property of convolution we can write

$$(f*g)*h = (f*h)*g$$

Both operation on LHS and RHS produces the same result but the computational complexity of the operations are different.

Computational Complexity:
Suppose f → x*y matrix.
Suppose h → x*y matrix.
and g is an image matrix → X*Y matrix.

Then the computational complexity for RHS is
O((x*y)*(x*y)) + O((x*y)*(X*Y))

And the computational complexity of LHS is
2*O((x*y)*(X*Y)) i.e. 1st convolving image with filter then again convolving the output image obtained with another filter.

As the size of filters f,h are much smaller as compared to the image size so Computation complexity of RHS is less as compared to that of LHS.

So RHS is considered as the most efficient way of convolution i.e. by convolving all filters first then convolve the image.

Que2.
This is the input image: [1 0 1 1 1 1 1 1]. What is the result of erosion with a structuring element [1 1 1]?

Solution2.
Output obtained after applying erosion:- [0 0 0 1 1 1 1 1]

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Que3.
Describe a possible flaw in the use of additive Gaussian noise to represent image noise.

Solution3.
The noise in the real world images can be caused due to various factor like: wind,sand fire and also the orientation of the camera. So this is the reason why modeling of noise with Gaussian may not describe the real world applications.

Que4.
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.
Solution4.

Assumptions:
1.)The camera is fixed at a particular place above the conveyor belt.
2.)There is no type of noise which can affect the photo taken by the camera.
3.)The time passed while taking image of 2 equipments are fixed. So that from video the unwanted frames can be removed.
4.) Has an ideal image from which we can compare the equipment image to find flaw in the particular image.

We can subtract the ideal image with the currently taken equipment image. On evaluating the output if the output pixels are examined to be above the certain threshold value we consider the image to be defective else not.

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Testing of the below functions can be done through testing.m script file.

Programming Problems [76 marks:]

1.)
Write a script called seam_carving_decrease_width.m which does the following by using the functions defined above:
a) Loads a color input image called inputSeamCarvingPrague.jpg. Download the image from
http://web.cs.ucdavis.edu/~yjlee/teaching/resources/inputSeamCarvingPrague.jpg
b) Reduces the width of the image by 100 pixels using the above functions.
c) Saves the resulting image as outputReduceWidthPrague.png. Submit it. Display this output
in your answer sheet. Submit the script.
d) Repeat the steps for an input image called inputSeamCarvingMall.jpg. Download the image
from http://web.cs.ucdavis.edu/~yjlee/teaching/resources/inputSeamCarvingMall.jpg. Save the output
as outputReduceWidthMall.png. Submit it. Display the output in your answer sheet.

Solution 1:

Figure1: InputSeamCarvingPrague

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Figure 2: OutputSeamCarvingReducedWidthPrague

The image in figure2 is the output obtained from the Seam Carving after reducing 100 pixels in the width of the image.

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Figure 3: inputSeamCarvingMall

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Figure4 : OutputSeamCarvingReducedWidthMall

The above image Figure4 is of OutputSeamCarvingMall with reduced 100 pixels.

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2.)[11 points] Repeat the above steps for both input images, but reduce the height by 50 pixels. Call the script seam_carving_decrease_height.m, and save the output images as outputReduceHeightPrague.png and outputReduceHeightMall.png, respectively. Display both outputs in your answer sheet. Submit the script for image inputSeamCarvingPrague.jpg

Solution 2:

Figure5 : outputReducedHeightMall

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Figure 6 : outputReducedHeightPrague

3.) [11 points] Display in your answer sheet: (a) the energy function output for the provided image inputSeamCarvingPrague.jpg, and (b) the two corresponding cumulative minimum energy maps for the seams in each direction (use the imagesc function). Explain why these outputs look the way they do given the original image's content.

Solution 3.)

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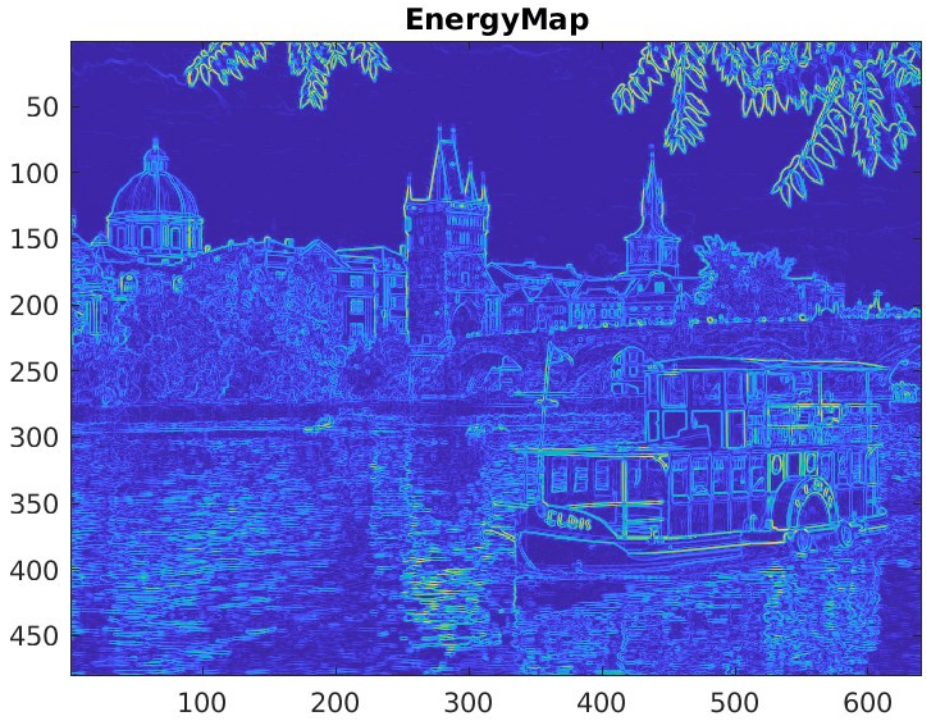

Figure7 : EnergyMapPrague

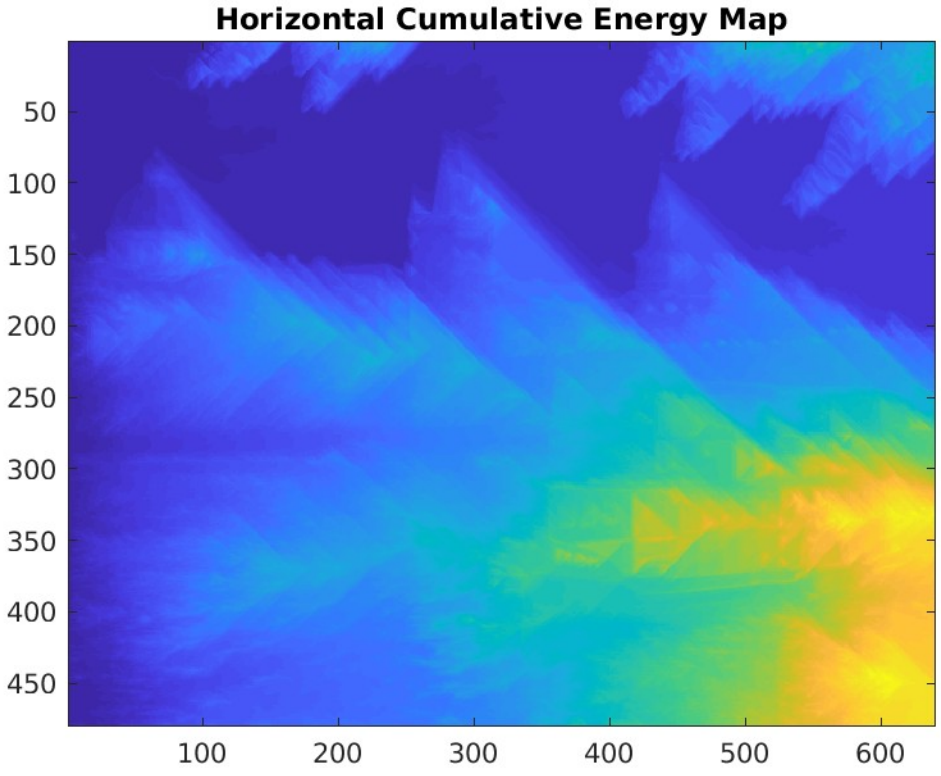

Figure8 : CumulativeEnergyHorizontalPrague

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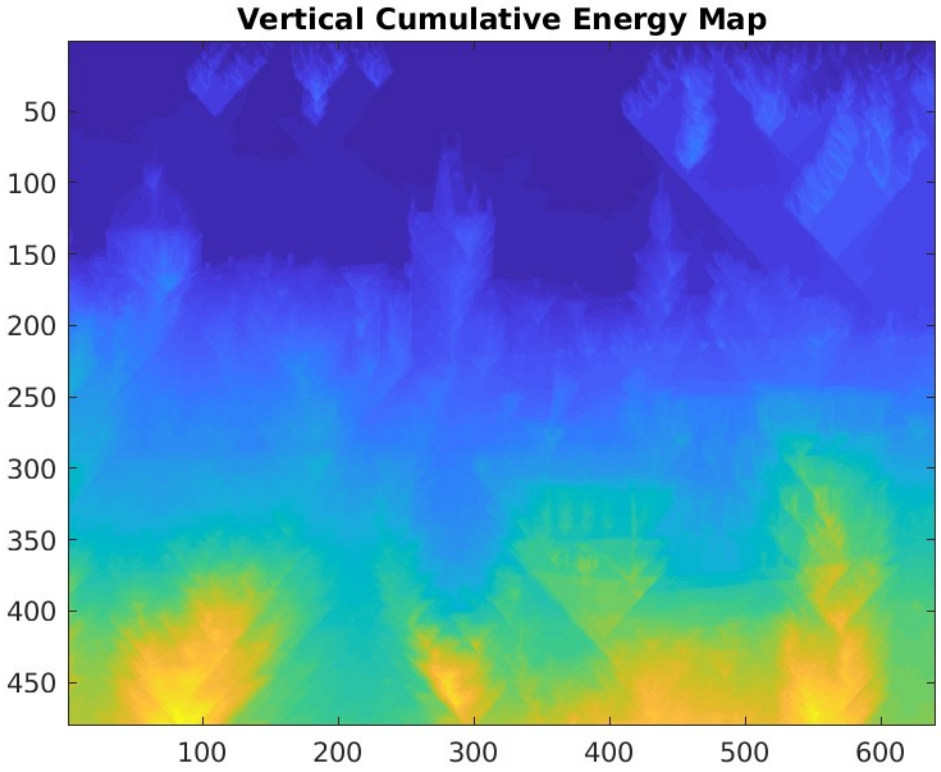

Figure 9: VerticalCumulativeEnergyMapPrague

Explanation for Figure 7: As the energy map is computed by Gx =(P(x+1) -P(x))/1 and similarly Gy = (P(y+1)-P(y))/1 so as we can see in the energy map that where ever we can find sharp change in pixel intensity i.e. on the boundaries or on the edges at those points the pixel intensities are very high. As well as the regions for which the nearby pixels are almost same we can see that those part are having very low intensity.

Explanation for Figure 8:
As the M matrix we computed for using dynamic programming will add up as we move from left to right that is one of the reasons for right most pixels having higher intensity as compared to the left most pixels. Another reason is we can see or note high intensity change for the regions for which intensities varies rapidly. For example in the above mentioned image the leaves. For these leaves the boundary of the leaves will vary with the high intensity so we can clearly able to see these area in the Horizontal Cumulative Energy Map.

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Explanation for Figure 9:
As the M matrix we computed for using dynamic programming will add up as we move from top to bottom that is one of the reasons for bottom most pixels having higher intensity as compared to the top most pixels. Another reason is if we see the the lake water we can notice that due to sudden change in the intensity because of the shadow of the building and sunlight we can see those area as high intensity zones.

4.)
[11 points] For the same image inputSeamCarvingPrague.jpg, display the original image together with (a) the first selected horizontal seam and (b) the first selected vertical seam. Explain why these are the optimal seams for this image.

Solution 4.)

Figure10 : VerticalAndHorizontalSeam

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As per the algorithm which runs from right to left for the horizontal seam and bottom to top for the vertical seam. We can say that the pixel considered before i.e. at the right most row and the bottom most column have the lowest intensity. And continuing from there we move by seeing the neighboring pixels of the lowest intensity range and make our horizontal and vertical seam to pass through those points. That's how we obtain the vertical and horizontal Seam for a given image. Removing or adding pixels at that point will not affect the complete image.

5.)
[11 points] Make some change to the way the energy function is computed (i.e., filter used, its parameters, or incorporating some other prior knowledge). Display the result and explain the impact on the results for some example. You need not submit this code.

Solution 5.)

There are several techniques for calculating the energy function i.e. either by thresholding or by using filters i.e. Gaussian and Laplacian

1.) Using thresholding to calculating energy map:
This means that we will only be keeping the pixels having the intensities more than a particular threshold and will be removing the pixels with the intensities less then threshold.

2.) Using filters for smoothing the image by using Gaussian filter to calculate makes the image less aware of the best optimal seam. On noticing Figure 14 we can tell that due to filtering the optimal positing of the seam in the image has changed.

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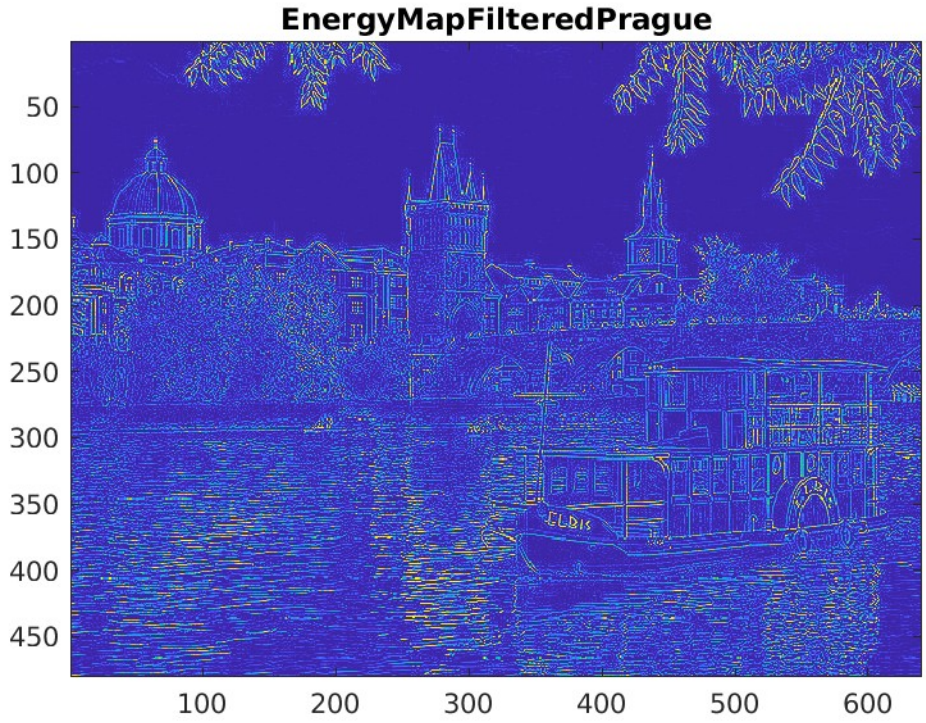

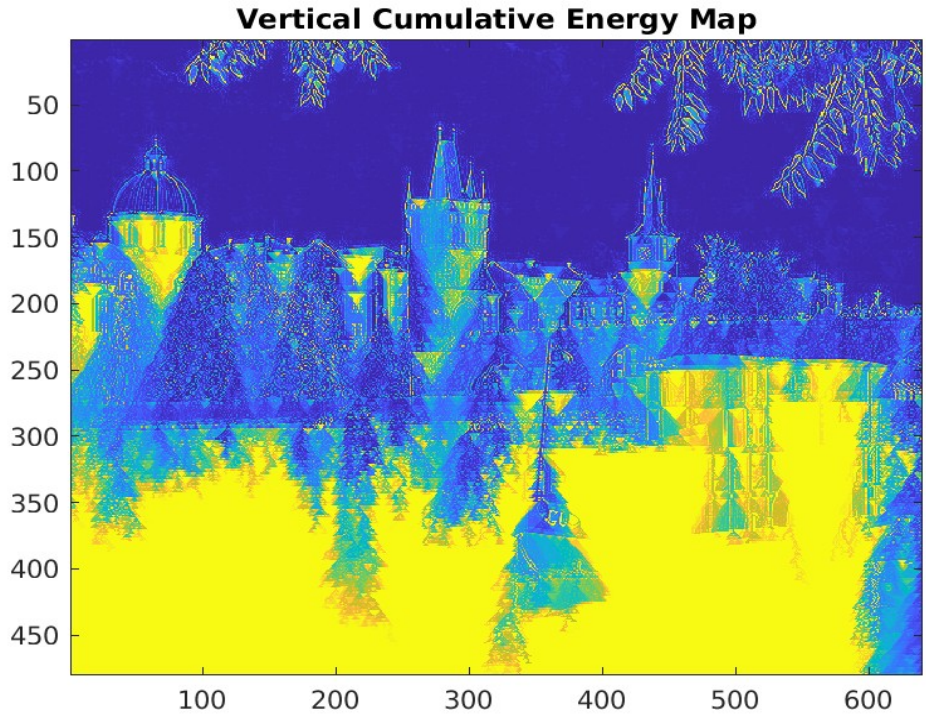

. *F igure12: Filtered Vertical Cumulative Energy Map*

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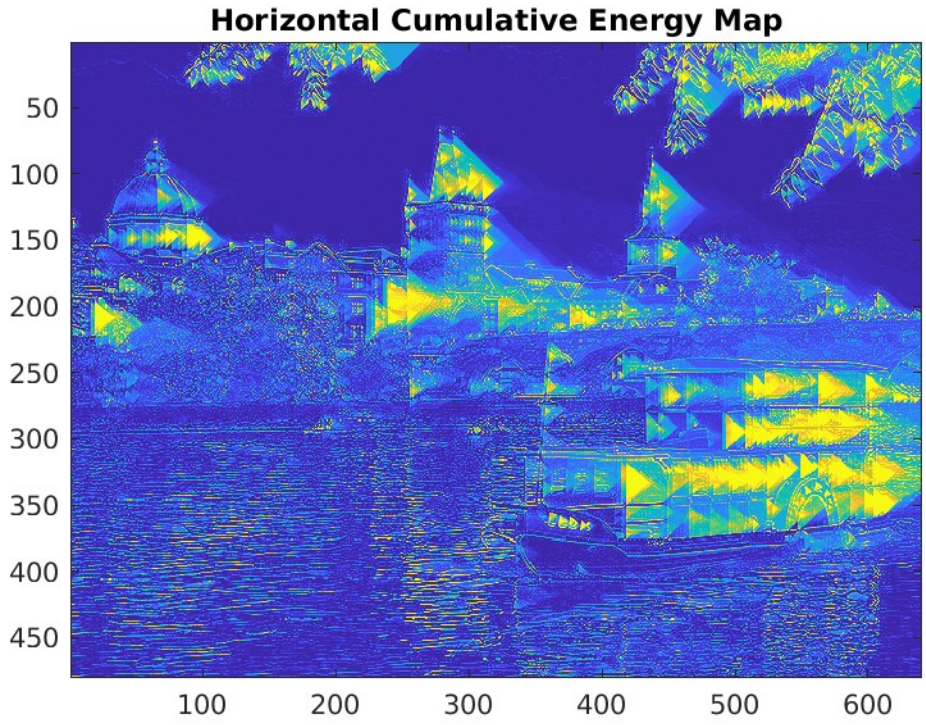

Figure13 : Filtered Horizontal Cumulative Energy Map

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Figure14 : Filtered Image Seam

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Que6.
[21 points] Now, for the real results! Use your system with different kinds of images and seam combinations, and see what kind of interesting results it can produce. The goal is to form some perceptually pleasing outputs where the resizing better preserves content than a blind resizing would, as well as some examples where the output looks unrealistic or has artifacts.

Include results for at least three images of your own choosing (be sure to credit any photo sources).Include an example of a “bad” outcome. Be creative in the images you choose, and in the amount of combined vertical and horizontal carvings you apply. Try to predict types of images where you might see something interesting happen. It’s ok to fiddle with the parameters (seam sequence, number of seams, etc.) to look for interesting and explainable outcomes. For each result, include the following things, clearly labeled (see title function) and using the subplot function for displaying the images:

a.)the original input image,
b.)your system’s resized image,
c.)the result one would get if instead a simple resampling were used (via Matlab’s imresize),
d.)the input and output image dimensions,
e.)the sequence of enlargements and removals that were used, and
f.)a qualitative explanation of what we’re seeing in the output.

Solution 6.
1.)
a.)
Input Image:

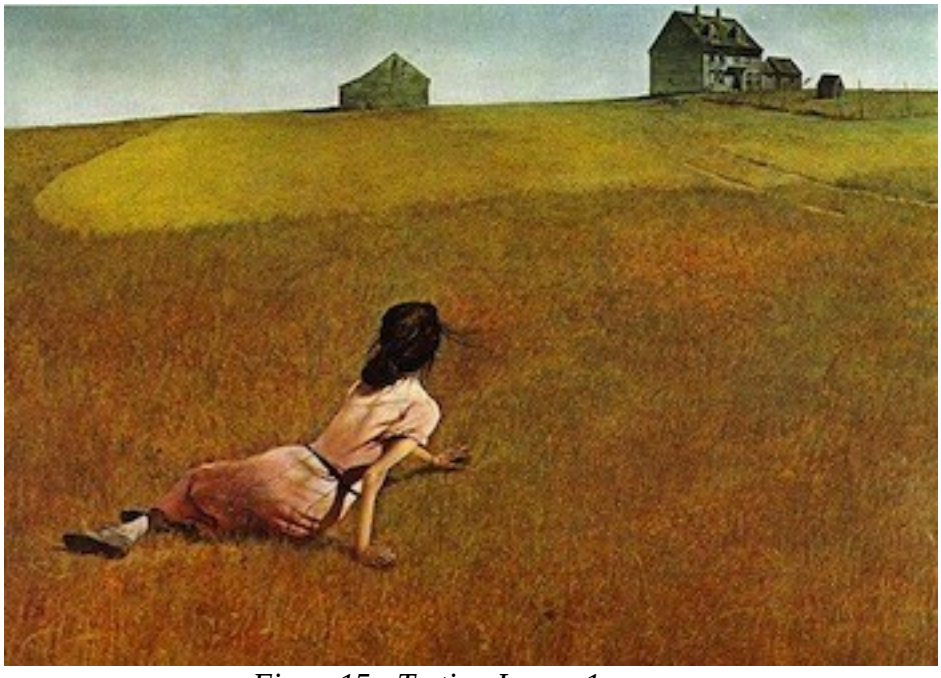

Figure15 : Testing Image 1

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Image Size:248 X 1050

b.)

Figure16 : Testing Image 1 Reduced Height

198X1050 are this image dimensions

Figure17 : Testing Image 1 with Reduced Width

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248 X 750

c.)
using method imresize() in matlab.

Figure18: ImageResizeReducedHeight

198X1050 are this image dimensions

Figure19: ImageResizeReducedWidth

248 X 750

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d.)
Input image dimensions:248 X 1050
Output image reduced height:198 X 1050
Output image reduced width: 248 X 750

e.)
Sequence of removal what are used are reducing 300 pixels from width for the reduced width image and 100 pixel from height from the reduced height image.

f.)
a qualitative explanation of what we're seeing in the output:

Figure20 : View Seam

This image is chosen for the analysis for providing an example for good seam carving and also as the pixel difference with its neighbor does not varies drastically i.e. image does not have many edges so that the optimized can be easily found and removed without any loss of important information from the given image.

Also while analyzing the output produced by the seam carving algorithm with the imresize function from matlab we can clearly see the difference between the two images of the girl. In case of matlab the whole image is scaled to girls image is compressed as compared with the output image from the seam. That shows the good output being produced by the seam carving algorithm. This results are found by analyses of Figure 17 and Figure 19.

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2.)

a.)

. *Figure21 : Testing Input Image 2*

Image size:968X4284

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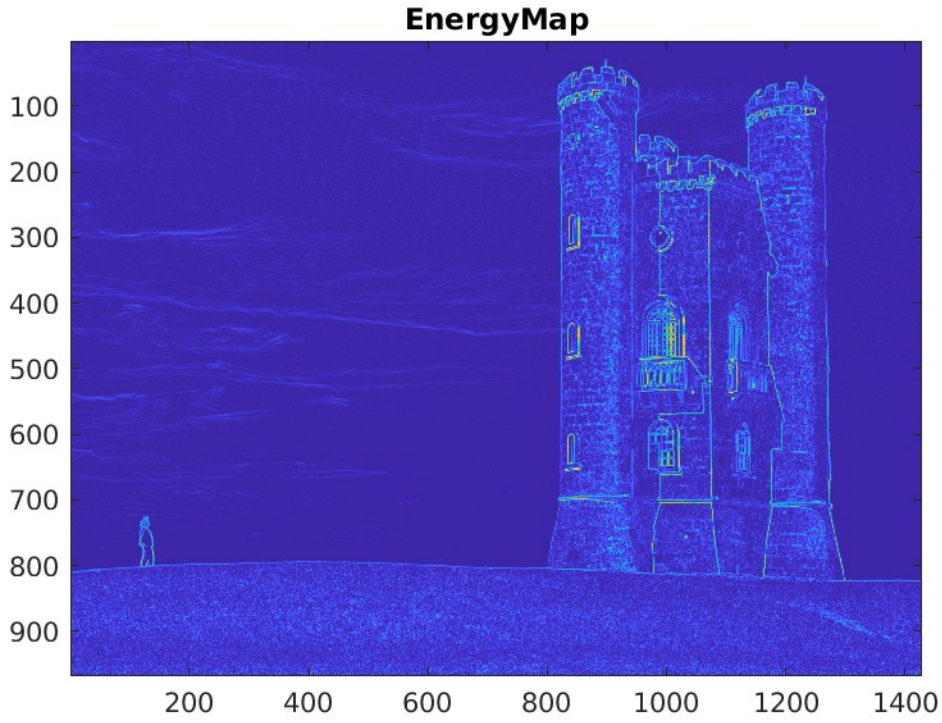

Figure22 : Energy Map Testing Input Image 2

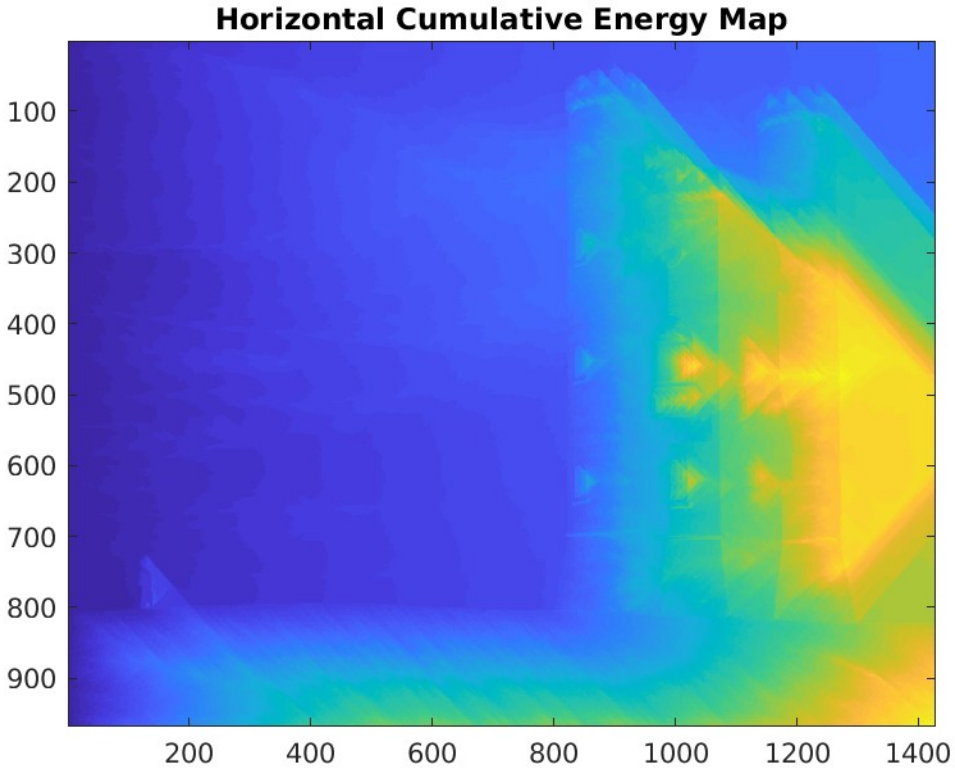

Figure23 : Horizontal Cumulative Energy Map For Input Testing Image 2

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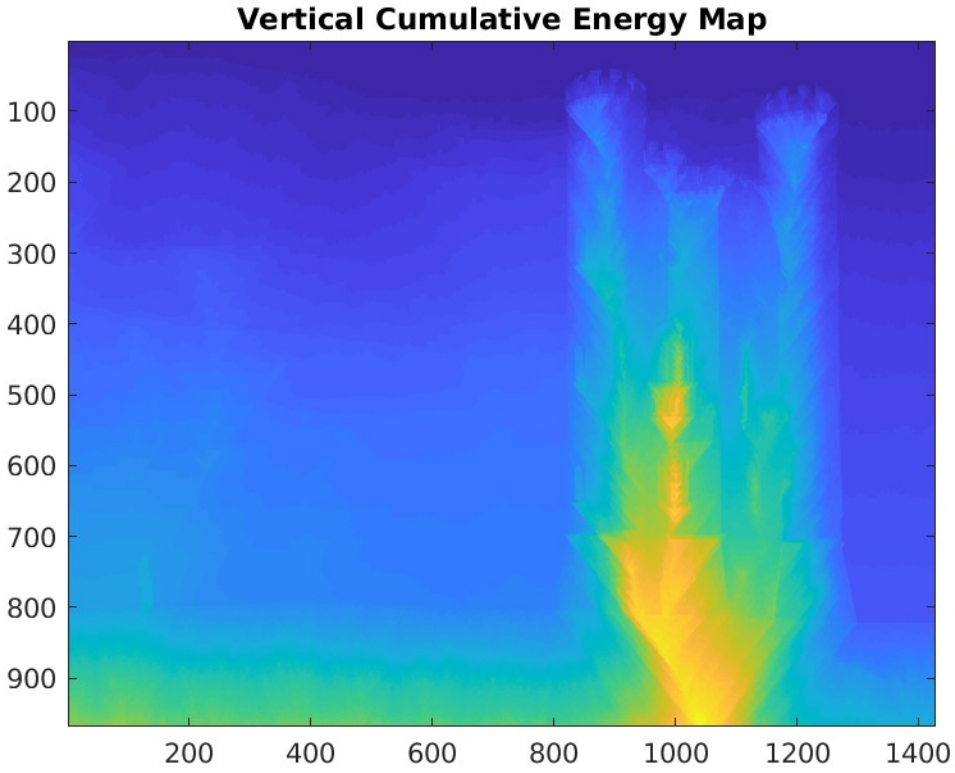

Figure24 : Vertical Cumulative Map For Testing Image 2

b.)

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Figure25 : Output Reduced Height for Input testing Image 2

Reduced Width: 968X4254

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Figure26 : Output Reduced Width Image of Testing Image 2

Reduced Height:958X4284
c.) Resizing image using imresize method in Matlab.

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Figure27 : Input image Reduced Height Resize

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Figure28: Input image Reduced Width Resize

d.)Original Image Size: 968X4284
Reduced Width: 968X4254
Reduced Height:958X4284

e.)
Sequence of removal what are used are reducing 30 pixels from width for the reduced width image and 10 pixel from height from the reduced height image.

f.)

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Figure29 : View Seam for Testing Image 2

This is also an example for good seam carving which is directly taken from the Wikipedia. This image is chosen for the analysis for providing an example for good seam carving and also as the pixel difference with its neighbor does not varies much so can also be seen from the Enery Map for the image provided in Figure 22 i.e. image does not have many edges so that the optimized can be easily found and removed without any loss of important information from the given image. Here the edges only corresponds to boundary of the tower.

Also while analyzing the output produced by the seam carving algorithm with the imresize function from matlab we cannot see the difference between the two images of the tower. As both of the output also looks alike the reason might me the pixels removed is less to find the significant change produced in the image obtained from seam carving reduced pixels and by resizing.

3.)
Actual Image Size:564 X 2866
Reduced Width: 564 X 2826
Reduced Height: 544 X 2866

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a.)

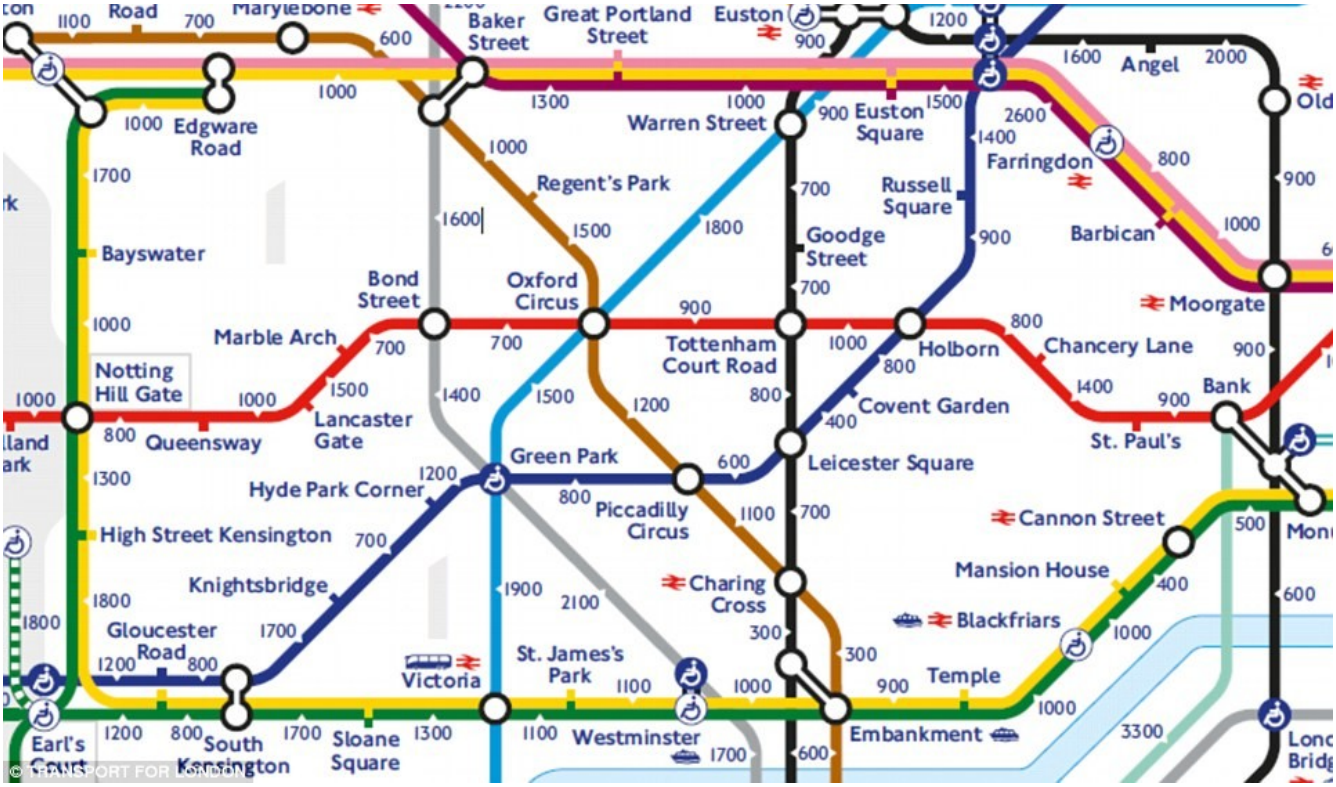

Figure30 : Testing Image 3 For Bad Example

564 X
2866

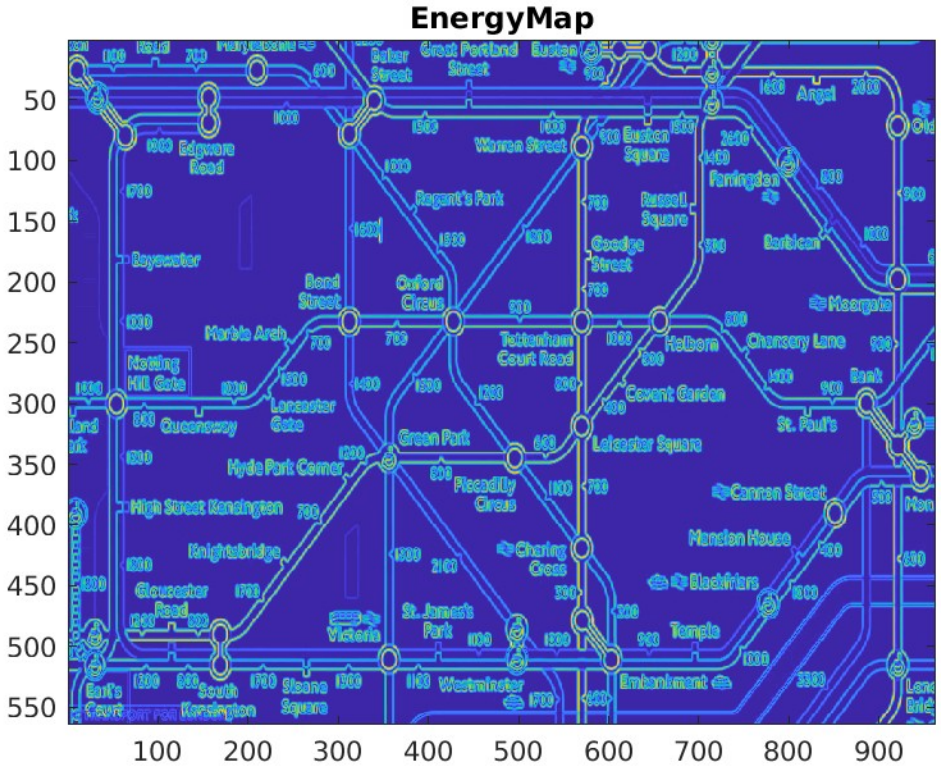

Figure31 : Energy Map For Testing Image 3

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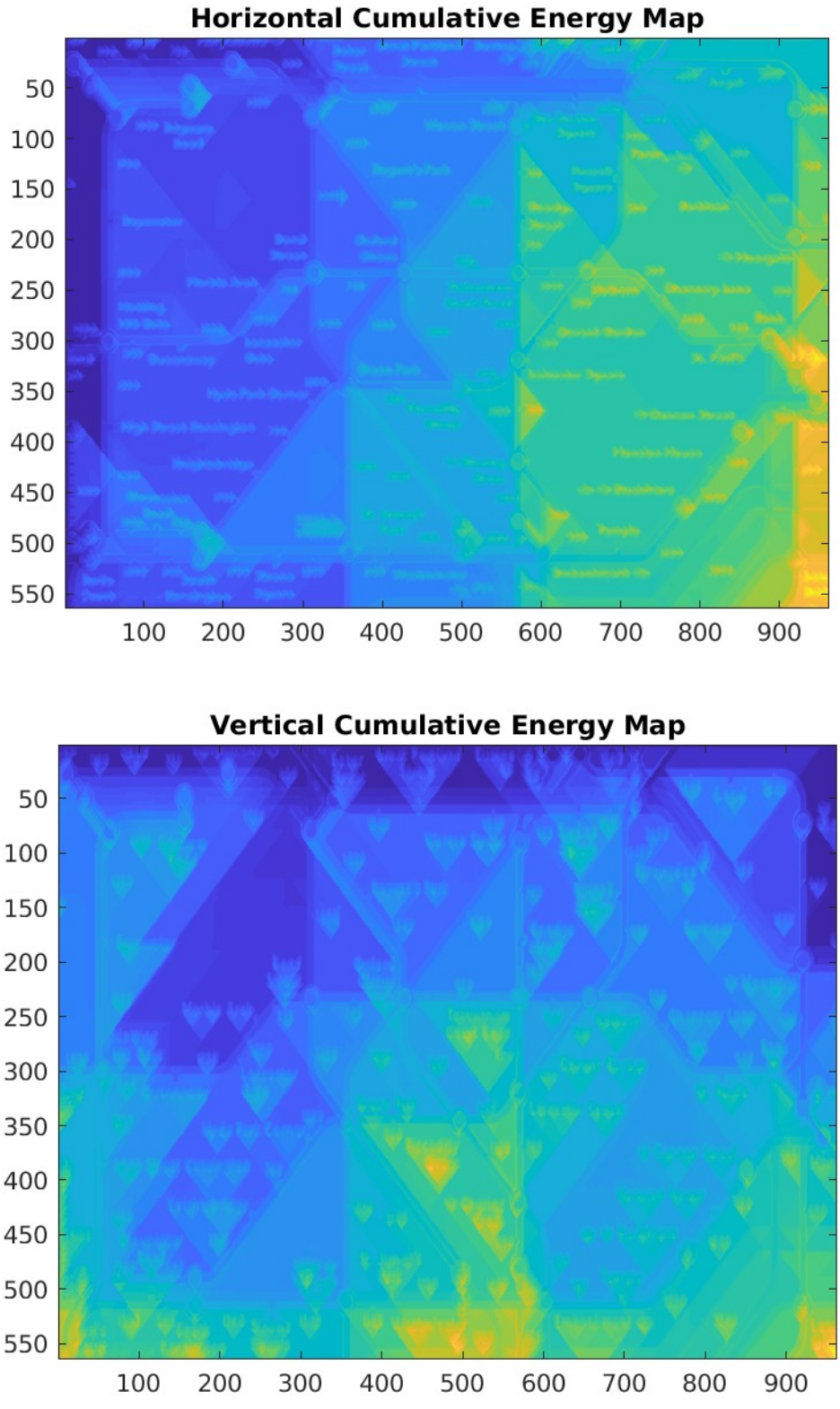

Figure33 : Cumulative Vertical Energy Map For Testing Image 4

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b.)

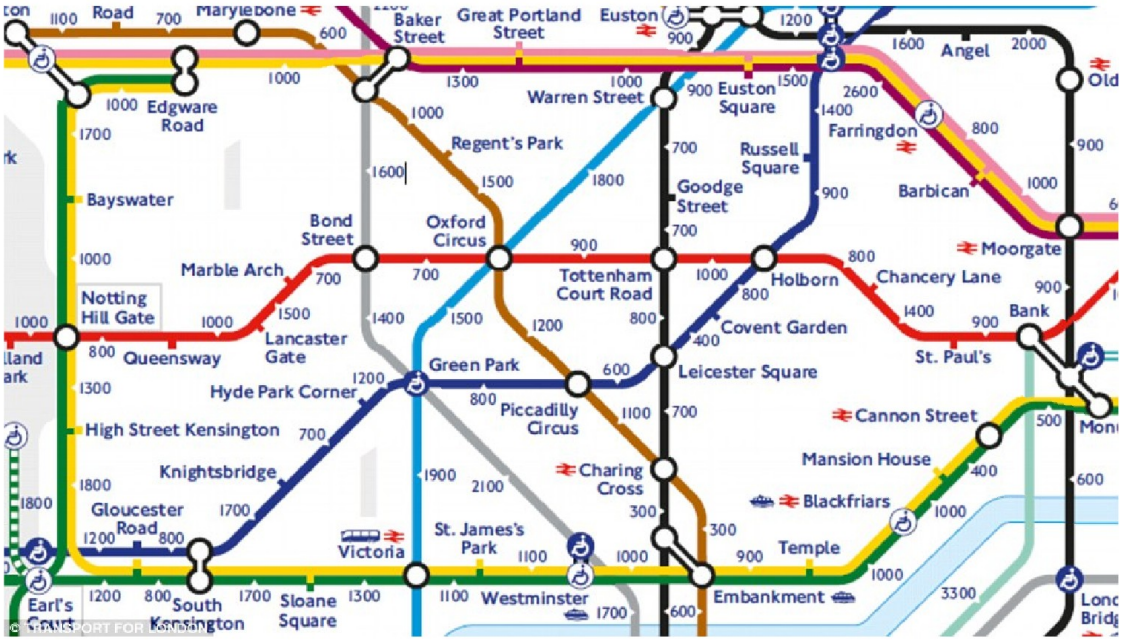

Figure34: Output Reduced Height Image For Testing Image 3

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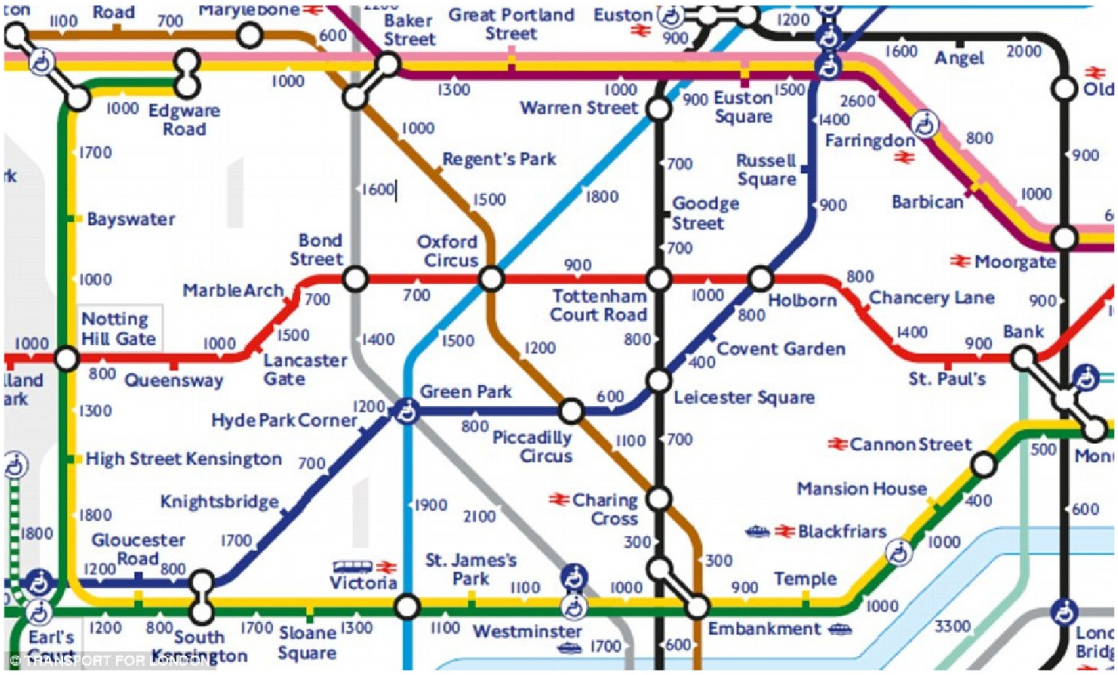

Figure35 : Output Reduced Width Images for Testing Image 3

c.)imresize()

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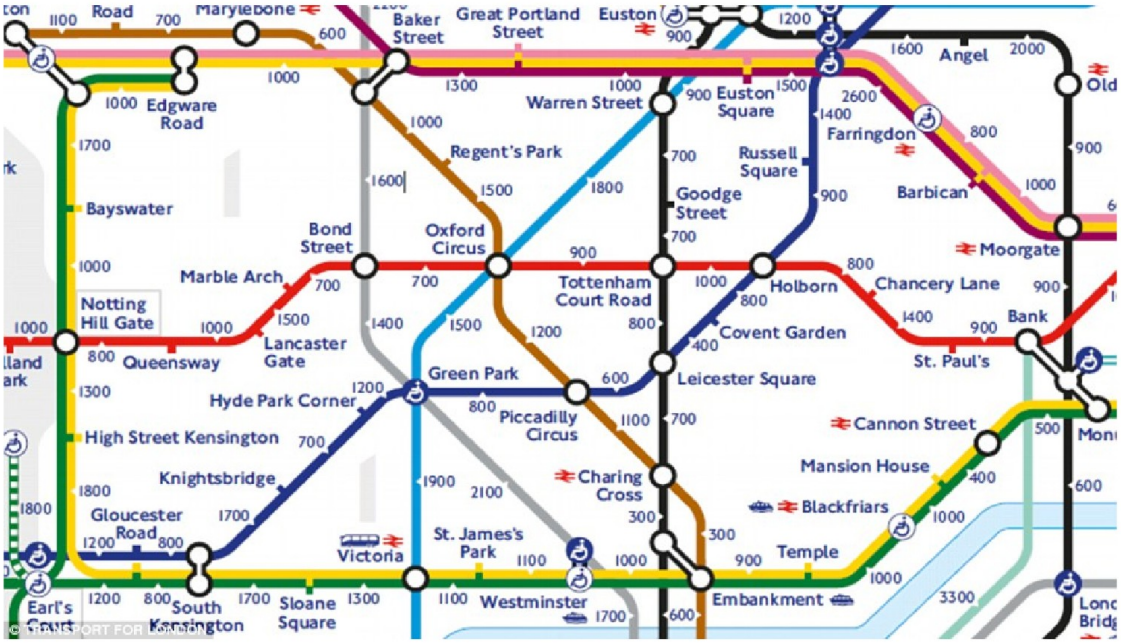

Figure36 : Output Reduced Height Resized Image

Figure37 : Output Reduced Width Resized Image

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d.)
Actual Image Size:564 X 2866
Reduced Width: 564 X 2826
Reduced Height: 544 X 2866

e.)Sequence of removal what are used are reducing 40 pixels from width for the reduced width image and 20 pixel from height from the reduced height image.

f.)
This is an example for bad seam carving which is taken from images from map.
This image is chosen for the analysis for providing an example for bad seam carving and also as the pixel difference with its neighbor does varies much so can also be seen from the Energy Map as the image consist of many edges , the image provided in Figure 31 Image does have many edges so that the optimized seam cannot be easily found and for the most optimal seam some of the important information from the given image will be removed.

So after analyzing the output produced by reducing the width and height of the image with the significant amount we can tell that some of the important information from the map about the railway stations are been lost so this is one of the limitation for the seam carving algorithm.

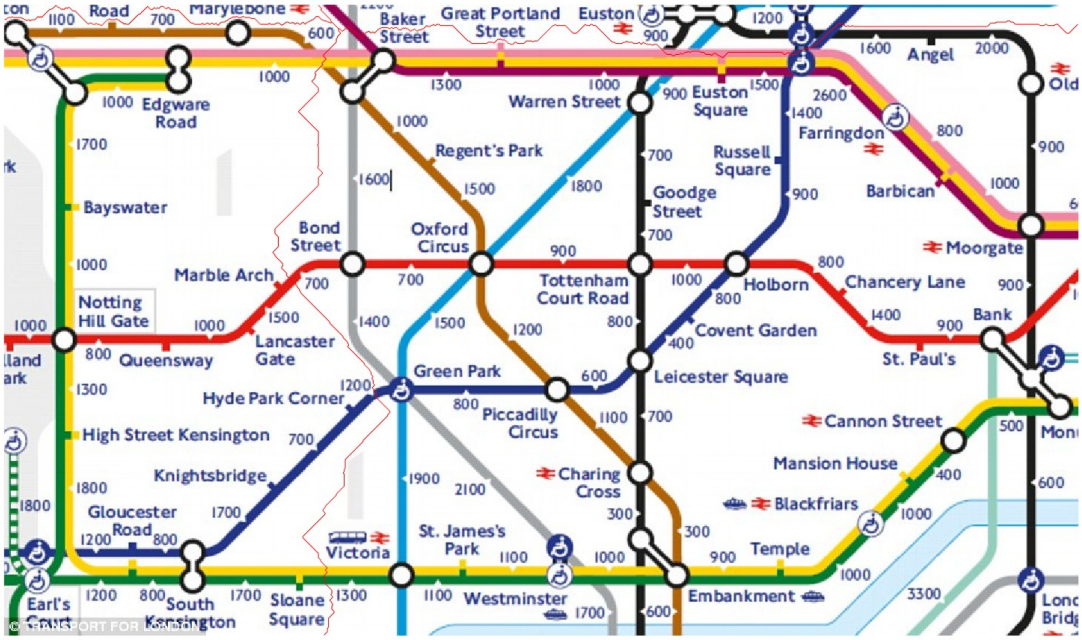

Figure38 : View Seam for Testing Image 3

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References and citation:

1.) Bad seam carving Image:
https://www.google.com/search?biw=1299&bih=653&tbm=isch&sa=1&ei=JmDqWuGSOOOV0gLjuLagBQ&q=many+ststion+map&oq=many+ststion+map&gs_l=psy-ab.3...1748800.1754769.0.1755022.16.15.0.1.1.0.270.1990.7j6j2.15.0....0...1c.1.64.psy-ab..0.11.1393...0j0i67k1j0i13k1j0i13i5i30k1j0i13i5i10i30k1.0.vp-out1RNqI#imgrc=ojYeGedyRVwfAM:
2.) Good seam carving Images:
https://www.google.com/search?biw=1299&bih=604&tbm=isch&sa=1&ei=JmDqWuGSOOOV0gLjuLagBQ&q=good+seam+carving+images&oq=good+seam+carving+images&gs_l=psy-ab.3...2174.11106.0.11197.26.25.1.0.0.0.166.2087.22j3.25.0....0...1c.1.64.psy-ab..0.13.1234...0j0i67k1j0i8i30k1j0i24k1j0i8i13i30k1.0.v4gmedfmjsk#imgrc=CPFzB9aBwRJtZM:
3.) Algorithm for Seam Carving:
https://en.wikipedia.org/wiki/Seam_carving
4.) Paper related to seam carving:

http://web.cs.ucdavis.edu/~yjlee/teaching/ecs189g-spring2015/seamcarving.pdf