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PS 1

ECS 174
May 2, 2019

I. Short Answer Problems

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

   A: If one would like to apply multiple filter to an image and the cost to apply a filter is expensive, one can use the associative property of convolution to cut down the numbers of filter before applying to an image.

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

   A: [1 1 1 1 1 0 1 1]

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

   A: Representing image noise ass additive Gaussian noise depends on noise variation along a normal distribution. Additive Gaussian noise does not work well for images where distribution of noise variation is skewed and not normal. Smoothing filters made specifically for normally distributed noise won't be as effective in this situation.

4. 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.

   A:

   - Let's assume that the part is in an environment where the part itself can be easily distinguished from the conveyor belt and any other surroundings to reduce noise.
   - The camera is perched above the conveyor belt.
   - The parts are assumed to have uniform size and shape under the camera and are evenly spaced from each other.
   - Let's also assume that there is a sufficient set of images or models of what the part should look like.
   - The raw image of each iteration of the part is converted to gray scale.
   - The image is then simplified into a more binary image by thresholding and is refined with dilation and erosion.

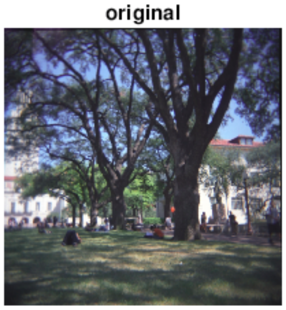
- An algorithm of connected components are used to separately identify key components of the part.
- The distance between these key components are compared to the average or range dictated by the reference model.
- If the calculated distances are out of the acceptable range, they are reported.

II. Programming problem: content-aware image re-sizing

1. Below are the images after undergoing seam carving. The resulting images are 100 pixels less in width.

   Output:

original



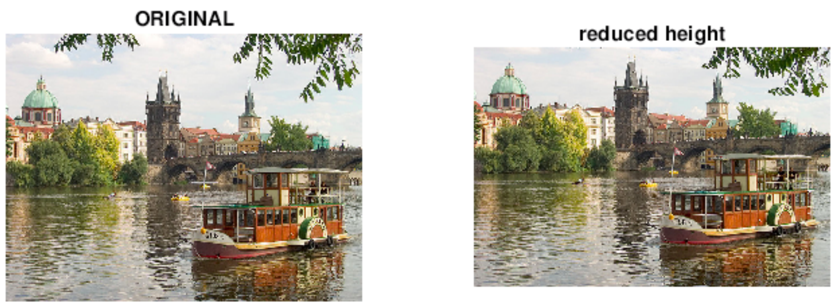
decreased pic

original

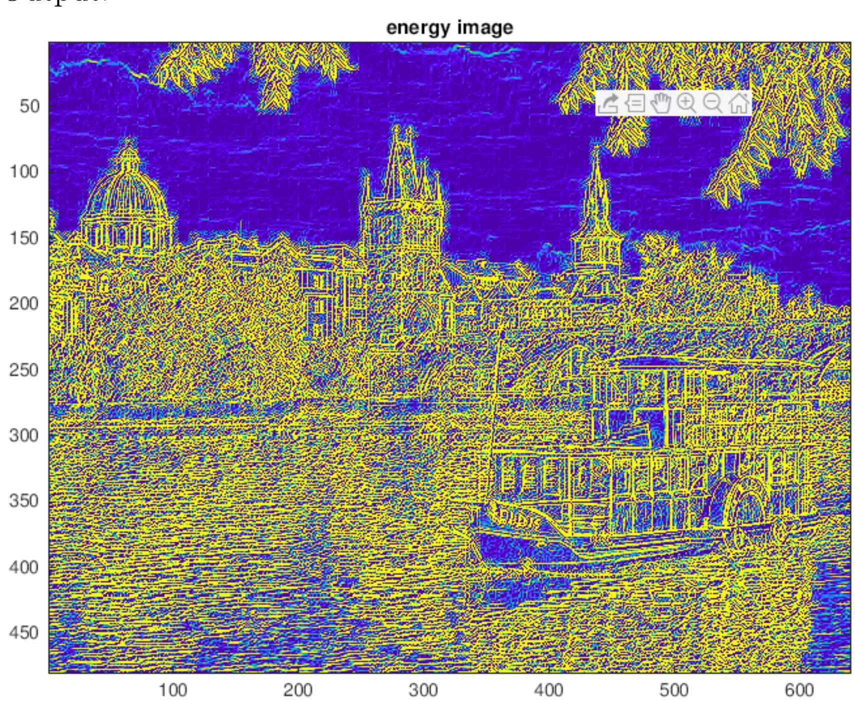
decreased pic

2. Below are the images after undergoing seam carving. The resulting images are 50 pixels less in height.

   Output:

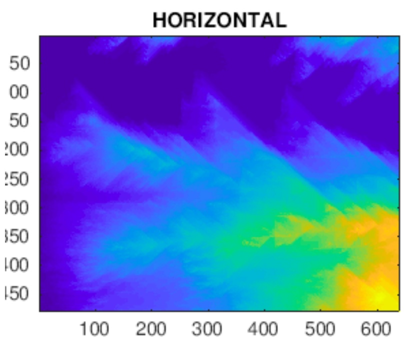


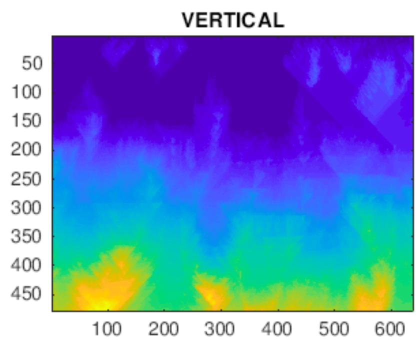
3. (a) This is the energy function output of the image inputSeamCarvingPrague.jpg.
Output:



(b) These two images are the cumulative minimum energy maps in the horizontal (top) and vertical (bottom) directions.

Output:



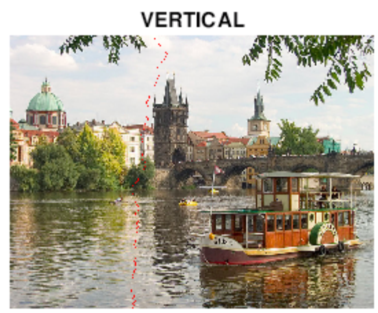


The energy function output show the outlines of the edges in the image. It also shows key components that our seam carving script should avoid when calculating the minimum cost path. The cumulative minimum energy then shows the key components more clearly. The white areas indicate high energy cost on the right of the horizontal energy map and at the bottom of the vertical energy map. This is because our cumulative energy map function sweeps through the image left to right for horizontal, and top to bottom for vertical.

In the horizontal cumulative energy map, high energy is shown at the large boat, buildings, and bridges. This is because we can't start compressing the boat image when we carve the image horizontal. The vertical cumulative energy map shows high energy cost at the areas such as the boat and the highly reflective parts of the water. We also avoid carving into the boats for this one.

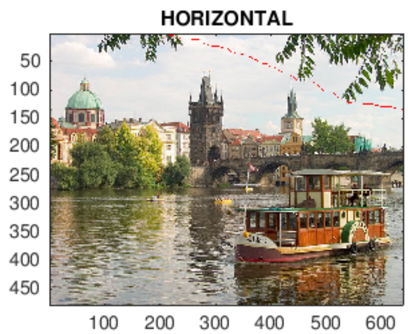
4. The following images relate to inputSeamCarvingPrague.jpg.

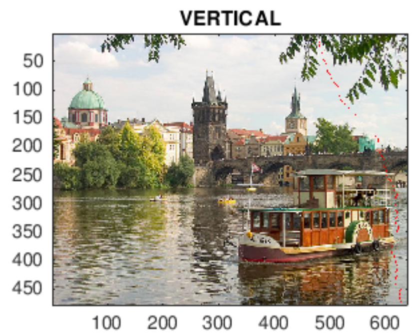
(a) The first image is the first selected horizontal seam. The second image shows the first selected vertical seam.
Output:



The first horizontal seam appears in the sky which has the same color and little contrast, so there is little cost to cut this seam out. The first vertical seam appears right through the edge of between the dark tower and the white building the seam would be a near vertical line. The vertical seam goes through the reflection of the white building because the colors are the same there, indicating low cost.

5. Results using the Laplacian filter:





The Laplacian filter is taking the second derivative of the energy map therefore the seam will cross over the region with the less dramatic changes in energy. So the vertical seam goes through the bridge rather than the buildings.

6. Test with random images

Photo by Oleg Magni from Pexels

This image includes the blue sky as the background therefore is prefect to test for height decrease. The blue sky has fewer edge than only other parts in this image. And the result indeed shows that the sky is being cut out.

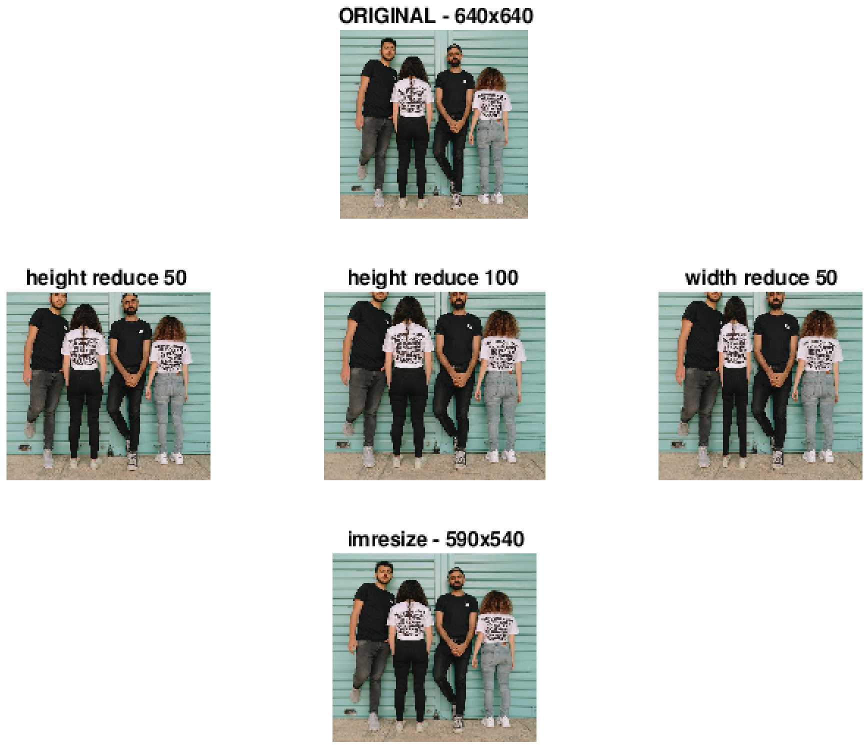


Photo by Fadi Dahabrah from Pexels

This image contents four people and they are wearing clothes with simple colors compare to the ground and the background. The algorithm sees that the ground is made of small shapes with different colors therefore it has a high energy value. The algorithm goes and cut off the head of the people and along their clothings. This could be taken as a bad result.

Photo by Fadi Dahabrah from Pexels

This image content a woman with green cloth that takes up most of the image. The algorithm first targets the top of the image because the hand has lower energy. And it continues that when cutting vertically to cut off the black background on the left.