Nicu Stiurca
ns7429
CS378

Pset1

1. Short answers
    1. First, invert the image, then apply a box filter roughly the same size as the holes.
    2. histogram
        1. for all pixel coordinates x,y in image I
            1. dx[x,y] := I[x+1, y] - I[x, y] – partial derivatives in x
            2. dy[x,y] := I[x, y+1] - I[x, y] – partial derivatives in y
            3. theta[x,y] := atan2(dy[x,y], dx[x,y]) – gradient orientation at [x,y]
            4. clamp theta[x,y] to the range [0, 2*pi)
        2. hist[1..n] := 0 – initialize all n bins
        3. binsize := 2*pi/n – compute the size of each bin
        4. for all pixel coordinates x,y in gradient map theta
            1. i := floor(theta[x,y] / binsize) – compute index of bin
            2. hist[i] := hist[i] + 1 – increment the appropriate bin
        5. return hist
2. Programming problem

Image 1: reduceWidth on seals.jpg with numPixels = 325

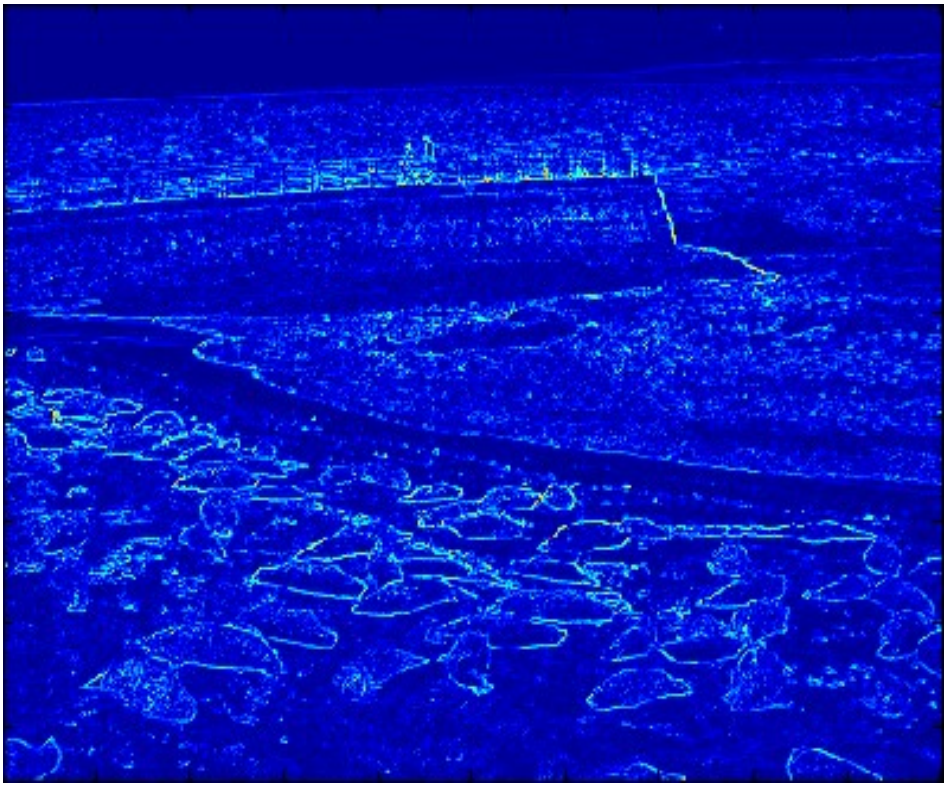


Image 2: seals.jpg - energy at each pixel

1. 1. See image 1
2. The energy at each pixel (image 2) corresponds to the amount of change in the picture at that location, revealing edges. Particularly pronounced edges are visible between the seals and the sand, the pier and the water, and the shore and the water. The horizontal cumulative image map (image 3) shows that the sky has very low cumulative energy since there is very little variation; likewise, seams along the shoreline (but not crossing

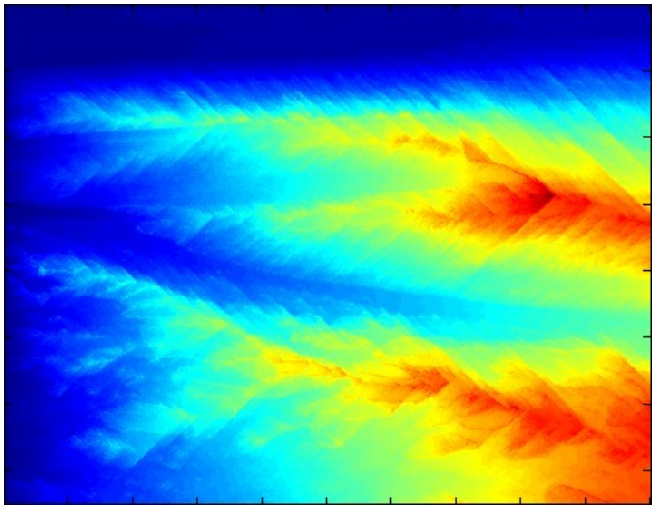


Image 3: seals.jpg - cumulative minimum energy map -- horizontal

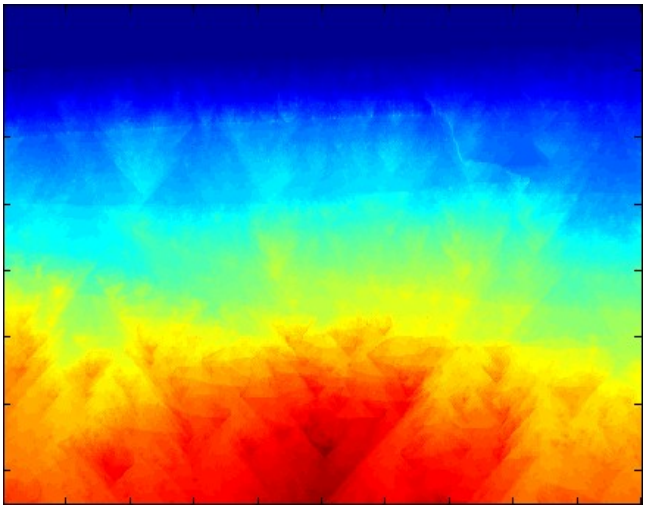


Image 4: seals.jpg - cumulative minimum energy map -- vertical

it) have relatively low cumulative energy. In contrast, the pier/waves/rocks and the seals on the beach cause areas of high horizontally cumulative energy. The total cumulative energy map in the vertical direction (image 4) reveals the nature of the image when traversing from top to bottom. As with the horizontal case, the energy level stays pretty low until the vertical seams reach the pier, at which point cost jumps up, and it jumps up again when the vertical seams invariably run into the shore and the seals. The lowest energy seams are on the right, where there is no pier and relatively few seals. The left side of the beach is also relatively clear of seals, so image 4 also reveals a some low vertical seams. The highest-cost vertical seams are in the middle, where they would have to pass through the people, the pier, the rocks, and lots of seals which have high-contrast edges.

3. In image 5, we see the first horizontal seam crossing the sky. Which is almost the same color all the way across, and thus has very low cumulative energy. In figure 6, we see the first vertical seam, which avoids crossing the pier and only crosses a beach-seal edge (these are high energy edges) twice.

Image 5: seals.jpg - first horizontal seam

Image 6: seals.jpg - first vertical seam

Image 7: seals.jpg - removed 325 vertical seams using [1; -1] filter

Image 8: seals.jpg - removed 325 vertical seams using a prewitt filter

Image 9: seals.jpg - removed 325 vertical seams using a sobel filter

4. 4. I re-computed 325 vertical seam removals from seals.jpg using a [1; -1], sobel, and prewitt filter. When using imfilter() with [1; -1] (as opposed to my implementation of computing the derivatives I used in Image 1), there were some serious artifacts. Specifically, the two seals at the bottom-right of the image become severely distorted.
   The prewitt and sobel filters (see images 8 and 9) turned out very similarly, with some advantages over the original method, as well as noticeable artifacts. On the plus side, the pier's right edge doesn't jut out like in the original computation. The pier also does not come out curved like in the original computation, but there is a large, sudden dip in it at the left side of the image.
   Furthermore, the prewitt and sobel filters cause the results to be much more jagged, which is especially visible by looking at the contour of the water against the sand.
5. Pics:
   1. Cathedral:
      1. Original:

2. Resized:

3. Resampled:

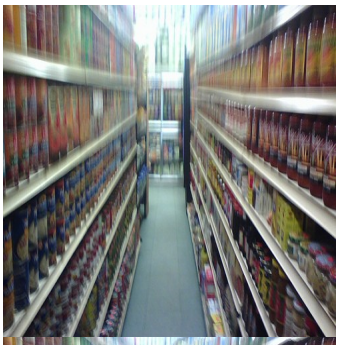
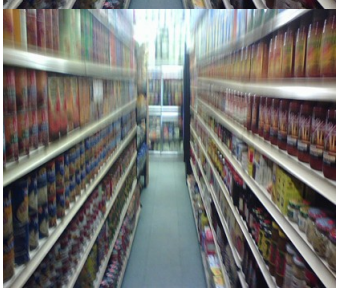
4. Original size: 604x453; new size: 579x308
5. removed 25 vertical seams, then 145 horizontal seams
6. What we're seeing: Much of the sky and some of the grass is gone, because they have low gradients, so content is preserved. Most of the content remains well-proportioned as well with the exception of the tower at the top middle of the picture. Overall a nice result.

2. Farmer:

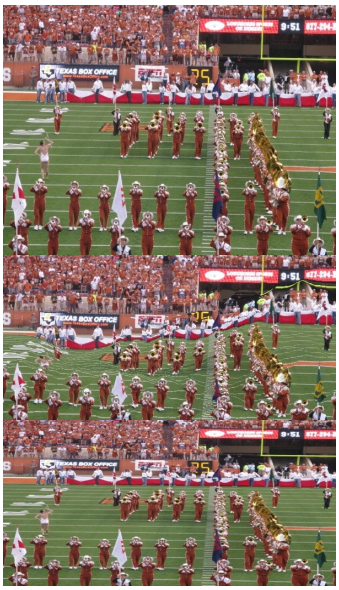
1. Original:

2. Resized:

3. Resampled: 
4. Original size: 453x604; new size: 353x504
5. removed 100 vertical seams, then 100 horizontal seams
6. What we're seeing: It looks like most of the removed horizontal seams reduced the sky to barely present, while a number of vertical seams passed through the farmer because his clothing has a relatively low gradient compared to the vegetation on either side of him

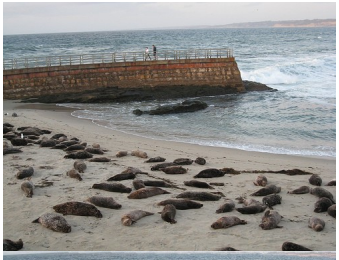
3. Groceries:
    1. Original: 
    2. Resized: 
    3. Resampled: 
    4. Original size: 500x375; new size: 425x350
    5. removed 75 vertical seams, then 25 horizontal seams
    6. What we're seeing: The center of the image is very distorted since the floor has a low gradient and the vertical seams are carved through the floor. Most of the rest of the picture has very high gradients, so it was left unaltered and thus undistorted.

4. Marching band:
    1. Original:
    2. Resized:
    3. Resampled:



    4. Original size: 604x453; new size: 604x303
    5. removed 150 horizontal seams
    6. What we're seeing: The seam carving algorithm does not preserve shape; it simply preserves areas with high gradients. Since the field has a very low gradient, multiple lowest paths are possible. Because of how my implementation breaks ties in the case of multiple lowest paths, the carved seams tend to be very wavy as we can see from the distorted yard lines. I suspect changing the tie-breaking behavior to favor straighter seams would improve the quality of the result.
5. Rubik's cube:
    1. Original:
    2. Resized:

3. Resampled: 
4. Original size: 453x604; new size: 300x300
5. alternated removing vertical and horizontal seams until the desired width was achieved, then removed horizontal seams until the desired height was also achieved
6. What we're seeing: Similarly to what we saw with the marching band picture, there are a lot of low gradient areas in this image, so the seams tend to be excessively wavy, which causes the cube to become wavy and distorted.

6. Seals:
   1. Original: 
   2. Resized: 
   3. Resampled: 
   4. Original size: 500x375; new size: 450x300
   5. alternated removing vertical and horizontal seams until the desired width was achieved, then removed horizontal seams until the desired height was also achieved
   6. What we're seeing: Most of the sky is gone since it has a very low gradient. The rest of the image looks nice, although the contour of the water against the sand is wavier than in the original picture for reasons already discussed. Since this is a much more natural scene, this side effect does not look bad, and the result is overall very nice.

7. Trees:
    1. Original:
    2. Resized:
    3. Resampled:

    4. Original size: 500x375; new size: 425x340
    5. alternated removing vertical and horizontal seams until the desired width was achieved, then removed horizontal seams until the desired height was also achieved
    6. What we're seeing: The low gradient parts of this image are inside the trunks/branches of the trees and their shadows, so those are the areas that are carved out. As a result, the trees become skinnier in the resized image. As with the seals image, the natural setting means that changes in shape and/or the proportions of objects isn't distracting, so this is a nice result.