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CSC320 Assignment 2 Report

Note: the last page of this report is a table of the images I used. The images were selected from my phone's camera roll and cropped/resized to widths of 300 pixels. I shot these in my neighbourhood during July 2016.

Why is image-set 1 (car) good for inpainting?

This image set has the following properties:

1. Alpha Mask:
    a. The majority of the alpha-mask is white, i.e. there is a very large "bank" of pixels/windows for the inpainting algorithm to choose from to fill in the fill-region. This allows the algorithm a wider variety of "guesses" as to what it "thinks" it should cut-and paste into the fill-region.
2. Source Image:
    a. The background is broken into distinct horizontal sections, all of which are fairly repetitive/uniform amongst themselves (e.g. the concrete wall is gray, with no obvious outlying pixels). These sections (and their borders) should all have consistent gradients, which helps the algorithm determine source regions more accurately. As long as the algorithm chooses a source-region in the same section as the destination-region, there is a high probability that it is a "good choice". In other words, the pixels in the source-region will probably be able to extend the pixels neighbouring the destination region, allowing for a good inpainting.
    The following is a list of the horizontal sections, listed from bottom to top:
        i. Asphalt
        ii. Side walk
        iii. Weeds
        iv. Concrete wall
        v. Dirt
        vi. Plants

Because the algorithm has a large amount of possible source-regions to choose from and a background with relatively discrete, uniform sections, it performs well. As we can see in the inpainted image, the horizontal sections seem to be extended logically to cover up the fill-region, resulting in a good inpainted image.

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Why is image-set 2 (telephone pole) bad for inpainting?

This image set has the following properties:

1. Alpha Mask
    a. A substantial portion of the alpha-mask is black, especially in the bottom half of the image (the bottom of the windshield and below). This means that the "bank" of source pixels is relatively limited, especially in the bottom half of the image. The smaller this bank of source pixels is when the algorithm begins, the more repetitive the final inpainted image will be. Thus, we are likely to see artifacts like "bands" of similar-color pixels.
2. Source Image
    a. The background does not have the same level of striation as the first image set. The road/curb section is relatively consistent, but the section(s) above are anything but.
    b. The algorithm will have to extend the grass (above the curb) to cover the car at that height. However, there are very few grass source-regions to choose. This means that extending the grass-region over the car will result in a highly repetitive band of pixels.
    c. The algorithm will have to interpolate the curb/grass boundary. Since the algorithm relies on previous in-paintings to compose the final inpainting, one mistake while reconstructing this boundary will have serious repercussions for the final inpainting. When extending the curb, if a source region is selected and pasted too high, the algorithm will then start extending this higher curb. This will result in two different "curb levels" and thus a bad inpainting.
    d. Another region of interest is the stone wall behind the car (visible above the top of the car). The algorithm must choose how it wants to treat this. Since the border between the stone wall and the grass in front of it is not visible in this image, the algorithm will probably do one of the following:
        i. Not extend the stone wall – this will result in a bad inpainting because the bottom border of the wall is defined by the car's, which means that when the car is filled in with greenery pixels, it will look like a well-camouflaged car was parked in front of the wall.
        ii. Extend the stone wall – this will result in a bad inpainting because there is no indication as to where the wall stops. Thus the algorithm runs the risk of creating an un-realistically long wall.

In summary due to poorly defined background regions and a small source-region bank, the in painting algorithm is likely to perform poorly on this image set.

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Artifact Discussion

Artifacts in First Inpainting

- In the bottom section of the image, the algorithm seems to have copy-pasted part of the side-walk on top of the asphalt (the side-walk's expansion groove is clearly visible). This is probably due to the fact that (our implementation of) the algorithm decides what source region to use on the basis of lowest SSD (sum of square differences). Since the side-walk and asphalt are relatively similar in color, the SSD between them is likely to be low, resulting in a high chance of sidewalk pixels being pasted onto where there should be asphalt. This problem is compounded when the algorithm makes further copy-pastes near this incorrect copy-paste – it will look for the most similar pixel groups, which will be sidewalk pixels, and make even more bad copy-pastes, continuing the cycle.
- There is a ghostly vertical band around where the left-edge of the pole used to be. This is probably due to the algorithm pasting in pixels from regions that are similar in terms of color but not location, so minute differences in shadowing will be seen, causing this artifact.
- The algorithm seems to have pasted bits of concrete over some dying grass (just above the concrete wall on the far right). This is probably due to the SSD between the dying grass and the gray concrete being very low, and the algorithm makes the same mistake as it did when pasting the sidewalk onto the asphalt.

Artifacts in Second Inpainting

- In the road/curb and grass sections of the image, there is a large amount of striations/bands in the inpainted image. This is most likely due to extending pixels using a source-region "bank" with little to no variation for road/curb or grass pixels. For the grass, this is especially obvious because unique features like dandelions are repeated over and over again near the curb.
- The curb seems to be higher on the left-half of the image than the right half, with a sharp jump down near the middle. This is probably due to the process that I described earlier – the algorithm kept extending a mistake, making it even worse. If we look at the source image, the curb is clearly higher in the left half than the right half, but both are approximately horizontally oriented. Since the algorithm would calculate the gradient to be 0 for both halves, with each half being at different heights, it would not be able to recognize that both of the halves are supposed to be continuous, thereby creating this jagged edge.
- The algorithm has pasted grass pixels into the foliage (top half, near the middle) – this is likely due to extending a gap in the foliage. Since the algorithm only pastes squares, this small foliage gap was turned into a sharp square (that does not match the foliage), making this artifact very obvious to a human observer.
- The issue that I discussed with the stone-wall not being extended properly has also arisen. It looks like a well-camouflaged car has been parked in front.

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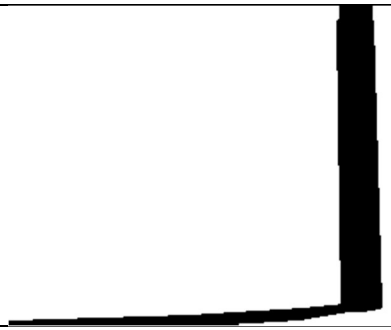
Table of Images

Image Set	Original	Mask	Inpainted
1 / Good			
2 / Bad