Digital Visual Effects Project 2

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The goal of this project is to take a set of pictures, and assemble a panorama, where we get a view with a wider angle. Our main approach was to implement the MSOP method which we were taught in class. Then we follow through with feature matching, image stitching, and last but not least, drifting.

1. Cylindrical Projection

We take image width, height, and focal length to warp all our images to cylindrical coordinates. This will give us smoother results when we stitch our images together. Cylindrical projection is implemented two times. For extracting and processing our feature points, we take in gray-scale images as input for efficiency. We do cylindrical projection again in color for warping the images itself.

2. Feature Detection

We implement Multi-Scale Oriented Patches with five scales, since with layers too high up we don't get too much effective points that can be used. For every scale, we smooth and scale down our original picture by 1/16. Using OpenCV provided functions, we get image gradients for x and y coordinates. Then we search for Harris corners, which are center points with corner strengths bigger than our threshold, 10. Our feature points are saved and added to a class called keyPointSet.

Non-Maximal Suppression

This is to refine our set of feature points. We set the size of our set at 500. For a pair of feature points, we calculate the distance between them. The feature points that are too close to each other are taken away from the final set of results.

Sub-Pixel Accuracy

We refine the location of the key points in 3 by 3 local regions, by taking derivatives and second order derivatives and comparing it to an offset.

Making Feature Descriptors

In 8 by 8 patches, we set up a description of the local image for our key points, which will enable easier and more efficient feature matching.

3. Feature Matching

We compare all feature points between two sets of feature points (each for a different image). Based on the feature descriptors we set up, we evaluate which descriptor in the other set is the point is most identical to. If the degree of their similarity goes beyond our threshold, then we identify them to be a matching pair.

4. Stitching

Once we obtain our pairs of feature points, we implement RANSAC, randomly choosing 3 pairs to calculate a matrix, so other pairs can use this matrix to calculate distance. We try to find the most pairs that will have a distance smaller than our threshold value. Then we do matrix transform on all the pixels on the right image so we can stitch it together with the left image.

5. Blending

Using bigger sized images with the black in the non-image areas, we calculate the overlapping parts between two images and implement linear blending for each row.

6. Drifting

We refine our resulting panorama image by taking the resulting width and height from our last step. Then we do inverse warping to obtain our results.

Best result

Issues we encountered

- This project is much more difficult than the first project, and we spent plenty of time on writing and debugging the code and also taking pictures.
- It took us a while to understand the algorithm behind the MSOP, image stitching and search for openCV functions to use.
- There're so many mathematic calculations behind the MSOP and image stitching algorithms, and we needed to be careful when implementing the math equations using openCV functions.
- We figured out that we shouldn't choose a scene with depth variations just like what the professor told us in the class, but we did make this mistake in the beginning with a few sets we took.
- The pictures we took by our own were giving us slight blurred results. The output is not as good as the sample picture's output.
- We took about 10 sets of picture in total, and finally got a desirable one. We learned a lot from this project, and got the chance to know openCV more. Image stitching is such a fun work but is more difficult than what we thought.

References

- http://research.microsoft.com/pubs/70120/tr-2004-133.pdf
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- http://g.csie.org/~edwardhw/courses/senior
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