Project 2: High Dynamic Range Imaging

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Introduction

Image stitching is a technique to combine a set of images into a larger image by registering, warping, resampling and blending them together. A popular application of image stitching is to create panoramas. Generally speaking, there are two classes of methods for image stitching: direct methods and feature-based methods.
In this project, we implement a feature-based method to generate panoramic images.

- Step 1: capture images
- Step 2: warp images into cylindrical coordinates
- Step 3: take the feature sets of two cylindrical images and apply the RANSAC algorithm to estimate the translational motion (pair-wise feature matching),
- Step 4: stitch and blend images in the order of matching and crop out the final panorama.
- Extension part: develop pyramid blending technique

The camera we used has the following parameters that are necessary when calculating the intrinsic matrix for distortion removal:

Canon A640, tag 4726208879	480x640	660.8799	-0.18533	0.21517

1. Capture Images (Emily and Giang)

We went to the Capitol and shot around outside scene at 20-degree intervals. Then 18 best images in 360 degrees are selected for the project.

Figure 1: State Capitol Building – outside scene

2. Warping each image into cylindrical coordinates (Emily)

We implement this section in the following steps:

I. Images are converted into cylindrical coordinates (**warpCylinder.m**)
II. Cylindrical coordinates are unwarped into a flattened image (**unwarpCylinder.m**)

3. Computing the alignment of the image in pairs (Giang)

We implement this section in the following steps:

I. Two feature detectors are implemented:
   - Harris feature detector (**HarrisFeatureDetector.m**)
   - Moravec feature detector (**MoravecFeatureDetector.m**)

II. We need to implement feature removal techniques to reduce the number of features
   - Feature removal by boundary (**FeatureRemovalBoundary.m**)
   - Feature removal by low contrast (**FeatureRemovalLowContrast.m**)
   - Feature removal by edge (**FeatureRemovalEdge.m**)

III. SIFT feature descriptor is implemented (**SIFTFeatureDescriptor.m**)
IV. RANSAC algorithm is used to eliminate the outliers (**RANSACMethod.m**)
V. Find all matching images and their connected sets (**ImageMatching.m**)

4. Stitching and cropping the result aligned images (Emily)

We implement this section in the following steps:

I. A linear alpha blending is used to blend 2 adjacent images (**blendImage.m**)

II. Implement an auto cropping technique by removing all the rows in the image that contain at least one non-scene black pixel resulting from the cylindrical projection steps (**perfectCrop.m**)

5. Creating the final result. (Giang)

Final image is imported into PanoramaStudio Pro 2.5.1 and converted to a 360 degree panorama.

The result is available at: http://humanrank.us/pano_capitol/capitol.html

6. Bonus

6.1 Pyramid blending technique (Emily and Giang)

We choose pyramid blending technique to replace the linear alpha blending technique in Section 4 for better results. The pyramid blending technique is implemented in following steps:

I. An application that can implement pyramid blending technique in 2 images at the same sizes, then output an image as a results. (**Giang**)

II. A more advanced application that can implement pyramid blending technique in images with different sizes. This version is implementing in the project in section 4. (**Emily**)

7. References

1. R. Szeliski and H.-Y. Shum. "Creating Full View Panoramic Image Mosaics and Environment Maps", SIGGRAPH 1997, pp251-258.
2. M. Brown, D. G. Lowe, "Recognising Panoramas", ICCV 2003.