Computer Vision

Final Project —— Panorama Stitching

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Background Introduction

Panorama Stitching has been a long standing problem in computer vision. The classical steps of find corresponds generally involve detection, finding descriptors invariant to scale and rotation, and finally, matching the interesting points with each other. In this project, we investigated and implemented the well-known algorithms for panorama stitching, namely, SIFT and SURF. We also offered a comparison between these two algorithms. Lastly, we also introduced an algorithm tailored for the mobile phone, a ubiquitous computing platform in the modern society.

SIFT

The SIFT algorithm uses LoG as the detector. After that, it needs to construct a scale space to find the characteristic scale for each interesting point. In this project, we zoomed into this procedure. It constructs a gaussian pyramid to represent different scales of the images. The process of building a pyramid includes using different sigmas to perform Gaussian convolution; continuously down-sampling the original image to obtain a series of images of different sizes; and making a difference between two adjacent images of the same octave to obtain an interpolated image. After that, the location of the extreme point is composed of the local extreme points in the DOG space, and the extreme points of 3X3X3 adjacent points are compared with the center point. Finally, return to the original Gaussian pyramid diagram, look for a Gaussian image close to $\sigma(scale)$, sample in the neighborhood window centered on the key point, and use the histogram to count the gradient direction of the neighborhood pixels.

SURF

The SURF algorithm is considered to be faster and more robust compared with SIFT. The SURF uses the Hessian matrix as the feature detector. The Hessian matrix is known for its ability to detect blob-like structure. In order to become a candidate for an interesting point, the product of the two eigenvalues of the Hessian matrix must be big and greater than zero. We can then use the determinant of the Hessian matrix(which equals the product of two eigenvalues) to detect the interesting points. SURF uses a box filter to approximate the Laplacian filter. It also uses integral image to further speed up the computation. The final descriptor of one SURF interesting point consists of 16 sub-region's haar wavelet response, each with 4 components.

The difference between SIFT and SURF is summarized as follows:

Table 1: Difference between SURF and SIFT

	SIFT	**SURF**
Speed	Slow	Fast
Feature Vector Dimension	128	64
Detector		
Approx Tricks	DoG LoG	Box Filter
Construction of Feature Vector	gradient	Haar Wavelet Response

Mobile Algorithm for Panorama Stitch

This algorithm addresses the problem of creating high-resolution and high-quality panoramic images from long image sequences with very different colors and luminance in source images. A fast stitching approach is proposed for combining a set of source images into a panoramic image using little memory, and implemented on mobile phones. In this approach, color correction reduces color differences of source images and balances colors and luminance in the whole image sequence, dynamic programming finds optimal seams in overlapping areas between adjacent images and merges them together, and image blending further smoothens color transitions and hides visible seams and stitching artifacts. A sequential panorama stitching procedure constructs panoramic images. The advantages include fast processing speed using dynamic programming for optimal seam finding, reducing memory needs by using the sequential panorama stitching.

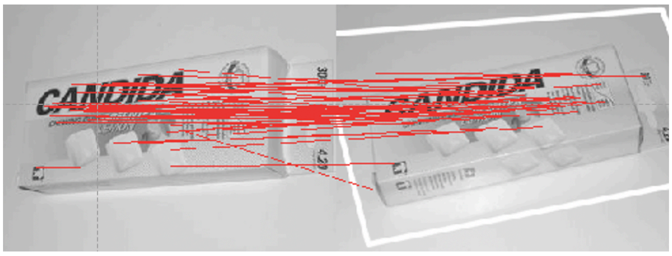

Figure 1: Image Stitch using SIFT

Figure 2: Image Stitch with SURF

Figure 3: Image Stitch with Mobile Algorithm

Reference

[1] Lowe, David G. "Distinctive image features from scale-invariant keypoints." International journal of computer vision 60.2 (2004): 91-110.

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[3] Xiong, Yingen, and Kari Pulli. "Fast panorama stitching for high-quality panoramic images on mobile phones." IEEE Transactions on Consumer Electronics 56.2 (2010): 298-306.