Conclusion

This paper introduces a new method for stitching images taken from 360-degree cameras with dual-fisheye lenses. It utilizes a novel two-step alignment algorithm that compensates for the mechanical misalignment between the two fisheye lenses and adaptively maximizes the similarity in the boundary regions of the images. The algorithm has been explicitly demonstrated to be effective in both off-the-shelf dual fisheye cameras and customized solutions. The proposed method can be rapidly implemented and demonstrates potential for use on a wide array of cameras, paving the way for future improved stitching solutions for 360-degree panoramic imagery.

Introduction

The Problem

The images generated by the dual-fisheye lens have limited overlap leading to unsatisfactory results when being stitched by the conventional feature-based stitching methods [1][2], as shown in Fig. 2. The overlap viewers' alignment causes misalignment between the two fisheye lenses and adaptively maximizes the similarity in the boundary regions of the images.

Our Approach

The proposed algorithm has four main steps, as shown in Fig. 3:

- **Light fall-off compensation:** measure and compensate for the intensity fall-off of the camera's fisheye lenses.
- **Fisheye Unwarping:** transform the fisheye images to an equiangular projection format that is viewable on 360-degree viewers.
- **Two-step alignment:** our proposed adaptive alignment to register the fisheye unwarped images.
- **Blending:** blend the aligned images using a linear function.

Light Fall-off Compensation

Use a polynomial curve to estimate the intensity fall-off from the center of the fisheye image.

Fisheye Unwarping

Convert the fisheye coordinates to 2-D spherical ones and derive the distance from the center of the sphere assuming equisolid angle relationship of the fisheye lenses. The output equiangular-projected image is viewable on 360-degree viewers such as PTGui 360 Viewer.

The Proposed Image Alignment

As shown in Fig. 7, after unwarping the images are not aligned with each other. Therefore, we proposed a novel two-step image alignment for dual-fisheye lens-generated pictures.

Fig. 2. Image stitching illustration. Left column: (a) Regular pictures with good overlap. (b,c) Feature matching using SIFT and outlier removal using RANSAC. (d) Image warping and panorama creation. Right columns: (e) Fisheye images taken by Samsung Gear 360 (f) Feature matching (using SIFT) and outlier removal (using RANSAC). Courtesy: VLFeat [2].

Fig. 3. The proposed light-fall off.

Fig. 4. (a) Image taken by Gear 360 that used to measure the light fall-off curve. (b) The light-fall-off curve reconstructed by a polynomial function. (c) The original fisheye image (light fall-off when moving away from center of the image). (d) The fisheye image after the compensation (the light fall-off is compensated for by multiplying the pixel values in the image by the inverse of the light fall-off curve).

Fig. 5. The Unwarping illustration.

Future Work

We would like to study more on an efficient auto color balance for the fisheye-generated images, and a weighted least-squares-based approach for the first image alignment to achieve more accurate stitching.

References