位相相関性を用いた画像間ズーム比の推定法

Phase Correlation Based Image Zoom Ratio Estimation

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1. Introduction

Zoom ratio is a very important parameter for estimating 3D object shape when using multiple images with different focal length [1]. In this paper, we propose a new approach for estimating zoom ratio between two images, based on phase correlation in frequency domain. The experimental results show that this method is robust to noise compared with intensity methods in spatial domain and can estimate zoom ratio large enough.

2. Phase Correlation

The method proposed is based on phase correlation that can be used in frequency domain for estimating the translation between two given images only different by a displacement (x_0, y_0):

$$I_2(x,y) = I_1(x - x_0, y - y_0) \qquad (1)$$

The cross power spectrum is computed with the Fourier transforms:

$$\frac{F_1^*(u,v)F_2(u,v)}{\left|F_1^*(u,v)F_2(u,v)\right|} = e^{-j2\pi(ux_0+vy_0)} \qquad (2)$$

Where F^* denotes the complex conjugate of Fourier transform F. It is now a simple matter to determine the amount of translation (x_0, y_0), since the inverse Fourier transform of the cross power spectrum is a correlation surface on which the location of the highest peak corresponds to the components of the relative displacement between two images.

3. Zoom Ratio Estimation

The method above could not be used directly for estimating zoom ratio. However, mathematically, after the Fourier transforms of two images are transformed to Log-Polar coordinates system, the zoom ratio and rotational angle can be estimated. Suppose two images have zoom ratio a and rotation angle θ_0, after converting the coordinate system into polar system, there exists following relation:

$$M_2(\rho,\theta) = M_1(\rho / a, \theta - \theta_0) \qquad (3)$$

Where M is the magnitude image of Fourier transformed result. The polar coordinate of the above magnitude image can be further converted to logarithmic coordinate:

$$M_2(\log\rho,\theta) = M_1(\log\rho - \log a, \theta - \theta_0) \qquad (4)$$

The motion parameters $\log a$ and θ_0 can be estimated using phase correlation method mentioned in section 1. Then the zoom ratio and rotational angle can be found. Using the estimated zoom ratio and rotational angle, one of image can be warped to another, the translation can also be estimated.

4. Experimental Results

In order to verify the validity, we had used several pairs of images with different zoom as input to the algorithm.

Fig. 1. Two original images with different focal lengths

Figure 1 shows two images (430 x 1024) taken with different focal length. After Fourier transform, the cross power spectrum and its inverse Fourier transform are computed. The zoom ratio is 1.772975, the rotational angle is 0.0 degree and after warping the translation is (-5.0,111.0) pixels. In the other image pairs, we had estimated zoom ratio of 2.433789. It is noted that how large the zoom ratio can be estimated depends on percentage of overlapping between two images. In the experiment we had found that the overlapping part should be over about 20%.

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REFERENCES

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