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信息科学

基于主成分分析的直线运动模糊参数估计

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摘要： 为了快速准确地估计直线运动模糊图像中的模糊参数，分析了直线运动模糊参数的长度和方向在频率域图像和倒谱图像中的表现形式，提出了一种基于主成分分析的运动模糊参数估计方法。首先，基于高斯建模对模糊图像中的倒谱图像进行二值化分割，得到倒谱图像中的亮线区域。然后，基于主成分分析提取亮线区域的主成分分量，主成分分量的方向即为模糊角度；依据估计的模糊角度，计算模糊图像傅里叶频率域图像相应角度的Radon变换，进行滤波去“毛刺”处理。最后，通过计算极小值之间的间距，估计模糊长度。实验结果表明：估计的模糊角度和模糊长度平均误差分别为0.138 4°和0.273 9 pixel，在同精度条件下，速度是传统的Radon变换方法的10倍左右，表明该方法能快速、准确地估计直线运动模糊参数。

关键词： 直线运动模糊 模糊参数估计 主成分分析 Radon变换

Parameter estimation of linear motion blur based on principal component analysis

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Abstract: To estimate the blur parameter of a linear motion blur image accurately and quickly, this paper analyses how the blur length and direction show in a frequency image and a cepstrum image, respectively, and proposes a motion blur parameter estimation method based on the Principal Component analysis (PCA). Firstly, the cepstrum image of the blur image was segmented in a binaryzation based on the Gaussian distribution modeling, and the highlight line region in the cepstrum image was obtained. Then, the principal component of the highlight line was extracted based on the PCA, and the direction of the principal component was the blur direction. After the blur direction was estimated, the Radon transform of frequency image for the blur image under the estimated direction was calculated, then the result of Radon transform was smoothed to reduce some artifacts. Finally, the blur length was estimated via calculating the interval between the two local-minimas of the Radon transform. Experiment results indicate that the errors of the estimated blur direction and length are 0.138 4° and 0.273 9 pixel, respectively, and the calculation speed is nearly 10 times faster than that of the traditional estimated method based on Radon method with the same accuracy. It concludes that the proposed method can estimate the blur parameter accurately and rapidly.

Keywords: linear motion blur blur parameter estimation principal component analysis Radon transform

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参考文献：

[1]HARMELING S, HIRSCH M, SCHOLKOPF B. Space-variant single-image blind deconvlution of removing camera shake [C]. Proceedings of Advances in Neural Information Processing Systems 23, 2010:829-837. [2]BABACAN S D, MOLINA R, DO M N, et al.. Bayesian blind deconvolution with general sparse image priors [C]. Proceedings of the 12th European Conference on Computer Vision, Florence, Italy, 2012:341-355. [3]KRISHNAN D, TAY T, FERGUS R. Blind deconvolution using a normalized sparsity measure [C]. Proceedings of the 12th European Conference on Computer Vision, Colorado, USA, 2011: 233-240. [4]石明珠,许廷发,张坤.运动成像混合模糊的全变分图像复原[J].光学 精密工程,2011，19(8):1973-1981. SHI M Z, XU T F, ZAHNG K. Total variation image restoration for mixed blur in moving image[J]. Opt. Precision Eng., 2011, 19 (8): 1973-1981. (in Chinese) [5]范赐恩,陈曦,张立国, 等.双CMOS成像系统中运动模糊图像的复原[J].光学 精密工程,2012，20(6): 1389-1396. FANG C E, CHEN X, ZHANG L G, et al.. Restoration of motion blurred image in dual CMOS imaging system [J]. Opt. Precision Eng., 2012, 20(6): 1389-1396 . (in Chinese) [6]冯亮,王平,许廷发, 等.运动模糊退化图像的双字典稀疏复原[J].光学 精密工程,2011，19(8): 1982-1989. FENG L, WANG P, XU T F, et al.. Dual dictionary sparse restoration of blurred images [J]. Opt. Precision Eng., 2011, 19(8): 1982-1989. (in Chinese) [7]MICHAL D, LIBOR M, TOMAS F. Blurred image restoration : A fast method of finding the motion length and angle [J]. Digital Signal Processing, 2010,10: 1677-1686. [8]WU Z Y, HUANG X H, LI X D, et al.. A simultaneous localization and mapping method based on fast-Hough transform [J]. Information Technology Journal, 2008, 7(1): 190-194. [9]FANG X Y, WU H, WU Z B, et al.. An improved method for robust blur estimation [J]. Information Technology Journal, 2011, 10(9): 1709-1716. [10]孙辉,等. 相位相关技术实现离焦模糊

图像运动估计[J]. 液晶与显示, 2012，27(2)：223-228. SUN H. Estimation of Displacement for out-of-focus blurred image using phase-only correlation[J]. Chinese Journal of Liquid Crystals and Displaqys, 2012, 27(2):223-228. (in Chinese) [11]LI H S, ZHANG Y N, ZHANG H C, et al.. Blind image deblurring based on sparse prior of dictionary pair[C]. Proceeding of 21st International Conference on. IEEE Pattern Recognition. 2012：3054-3057. [12]BISHOP C M. Pattern Recognition and Machine Learning[M]. New York：Springer, 2006.

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1．黄伟国 顾超 朱忠奎.用于目标识别的PCA-SC形状匹配算法[J]. 光学精密工程, 2013,21(8)：2103-2110