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信息科学

湍流退化红外图像降晰函数辨识

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摘要： 针对高速湍流场导致的红外成像模糊，提出了一种基于图像质量评价的湍流退化红外图像降晰函数辨识算法。利用先验知识将退化过程简化为可用参数描述的二维高斯函数形式，将退化图像分割为边缘区、纹理区和平坦区，计算不同支持域下复原图像在不同参数时的峰度值；利用曲率最大准则对得到的“峰度-参数”曲线进行相应的降晰函数参数估计，进而由支持域和对应的估计参数得到对应降晰函数并用于复原退化图像；最后对复原图像进行无参考图像质量评价,评价指标最高的复原图像对应的降晰函数即为最终辨识结果。实验结果表明：该算法能较好地辨识降晰函数参数和支持域大小，当退化图像信噪比大于30 dB时，估计参数与真实值的最大偏差小于±5%。该算法所得结果可以作为湍流退化红外图像其他复原算法的降晰函数起始估计。

关键词： 气动光学效应 湍流退化 红外图像 图像质量评价 降晰函数辨识

Blur identification of turbulence-degraded IR images

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Abstract: A novel algorithm based on image quality assessment was proposed for a turbulence-degraded infrared image to deblur the fuzzy infrared image caused by a high-speed turbulent flow field.Firstly,the degradation process was simplified as parameter-describing 2-D Gaussian function according to the prior knowledge, the degraded image was segmented into edge region, texture region and plain region and the weighted average of those regional 2-D kurtosis were used as the image kurtosis. Then, the kurtosis of restored image varying with the parameter under different support regions was calculated and the curvature-maximum criterion was used to estimate the corresponding parameter from the “kurtosis-parameter” curve. After that, the Point Spread Function(PSF) determined by the support domain and corresponding estimated parameter were used to restore the degraded image. Finally, a no-reference image quality assessment was used to compare different restored images,and the PSF of the recovered image with the highest quality was regarded as a final identification result. Experimental results show that the proposed algorithm can identify the parameter and support region of the blur function well, and the maximum deviation of the estimated parameter and the real value is less than ±5% when the Signal to Noise Ratio(SNR) of the degraded image is larger than 30 dB. The identification results can be used as an initial PSF estimation for other turbulence-degraded infrared image restoration algorithms.

Keywords: aero-optical effects turbulence-degradation infrared image image quality assessment blur identification

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