

光电信息获取与处理

合成孔径光学系统的成像特性和图像复原

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摘要:

以Y-4合成孔径系统为基本结构, 分析和比较了不同填充因子Y-4系统的U-V平面覆盖、点扩散函数和调制传递函数特性; 用Zemax和Matlab软件对系统进行模拟成像, 利用维纳滤波和改进的维纳滤波对加噪图像进行复原, 使用峰值信噪比(PNSR)标准比较了不同填充因子Y-4系统的复原效果, 并分析了影响合成孔径系统成像质量和复原效果的因素。结论如下: 通过图像复原, 可以极大地改善合成孔径系统所成图像的像质, 提高图像的清晰度, 使得复原后的图像和其等效单孔径系统所成的像很接近, 实现大孔径成像系统的观测效果; 图像复原的效果与合成孔径系统的阵列结构和噪声类型有关。

关键词: 合成孔径光学系统 U-V覆盖 点扩散函数 调制传递函数 维纳滤波 图像复原

Imaging characteristic and image reconstruction of synthetic aperture optical system

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Abstract:

Optical synthetic-aperture imaging is one of the most potential techniques for improving the resolution of system. U-V coverage, PSF and MTF of synthetic-aperture system were analyzed with different fill factors. They were discussed on the basis of Y-4 system. This study also generated image simulation of Y-4 system with the help of Zemax and Matlab software, and restored the images with noise making use of Wiener filter and the modified Wiener filter. Reconstruction results of Y-4 system with different fill factors were analyzed and compared with the help of PNSR. The factors which affected the image qualities and reconstruction results of synthetic-aperture system were also analyzed. The results show that image restoration could improve the image quality of synthetic-aperture system and increase its definition, its image quantity is equivalent to a single aperture system and it can achieve the same effect as big aperture system, and the results of image restoration are dependent on the array structure of synthetic-aperture system and noise types.

Keywords: synthetic-aperture optical system U-V coverage PSF MTF Wiener filtering; image reconstruction

收稿日期 修回日期 网络版发布日期

DOI:

基金项目:

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参考文献:

[1] CHUNGL S J.Design, implementation and control of a sparse aperture imaging satellite [D].USA:Massachusetts Institute of Technology, 2002.
[2] ZHENG Yu-feng, GUI Xiao-hui,MARK P,et al. CT scout z-resolution improvement with image restoration methods [J].SPIE,2003,5032: 1851-1857.
[3] 王大勇,伏西洋,郭红锋,等.光学稀疏孔径系统的成像及其图像复原 [J].光子学报,2005,34(10):1557-1560.

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- WANG Da-yong, FU Xi-yang, Guo Hong-feng, et al. Imaging and image reconstruction of optical sparse-aperture systems [J]. Acta Photonica Sinica, 2005, 34(10): 1557-1560. (in Chinese with an English abstract)
- [4] 吴泉英, 钱霖, 沈为民. 稀疏孔径系统的成像和图像复原 [J]. 激光杂志, 2005, 26(6): 40-42.
WU Quan-ying, QIAN Lin, SHEN Wei-min. Image recovering for sparse-aperture systems [J]. Laser Journal, 2005, 26(6): 40-42. (in Chinese with an English abstract)
- [5] 吴泉英. 稀疏孔径光学系统成像研究 [D]. 苏州: 苏州大学, 2006.
WU QUAN-ying. Study on the sparse aperture optical systems [D]. Suzhou: Suzhou University, 2006. (in Chinese)
- [6] 易红伟. 光学稀疏孔径成像系统关键问题研究 [D]. 北京: 中国科学院研究生院, 2007.
YI Hong-wei. Study on the key issues of the optical sparse aperture imaging systems [D]. Beijing: Graduate University of Chinese Academia of Science, 2007. (in Chinese)
- [7] 吕乃光. 傅里叶光学 [M]. 2版. 北京: 机械工业出版社, 2006.
LU Nai-guang. Fourier optics [M]. 2nd ed. Beijing: Mechanical Industry Press, 2006.
- [8] 王海涛, 周必方. 光学综合孔径干涉成像技术 [J]. 光学·精密工程, 2002, 10(5): 434-442.
WANG Hai-tao, ZHOU Bi-fang. Optical synthesis aperture interference image technology [J]. Optics and Precision Engineering, 2002, 10(5): 434-442. (in Chinese with an English abstract)
- [9] 王爱玲, 叶明生. MATLAB-R2007图像处理技术与应用 [M]. 北京: 电子工业出版社, 2008.
WANG Ai-ling, YE Ming-sheng. Matlab-R2007 Image processing technology and application [M]. Beijing: Electronic Industry Press, 2008. (in Chinese)

本刊中的类似文章

1. 拜晓锋. 像增强器MTF测量理想像面选择方法研究[J]. 应用光学, 2009, 30(2): 300-303
2. 张湜酥; 赵剡; 许东. 基于几何光学的红外成像模型[J]. 应用光学, 2008, 29(4): 565-571
3. 孙江芹; 钱霖; 吴泉英. 轴对称综合孔径光学系统的调制传递函数和成像性质[J]. 应用光学, 2008, 29(4): 548-552
4. 易红伟; 李英才; 王矫; 樊超. 稀疏孔径结构优化的蒙特卡罗反演方法[J]. 应用光学, 2008, 29(supp): 130-135
5. 陈粉宁; 许峰; 刘朝晖; 折文集. 综合孔径在光电经纬仪动态成像中的应用[J]. 应用光学, 2008, 29(supp): 8-11
6. 朱锡芳; > 吴峰. 基于小波阈值法和维纳滤波的稀疏孔径光学系统成像的恢复[J]. 应用光学, 2007, 28(5): 526-530
7. 车双良; 赵创社. 亚像元动态成像技术中系统调制传递函数的数值分析[J]. 应用光学, 2004, 25(2): 19-21
8. 关英姿; 韩四宁. CCD相机调制传递函数测试软件的研制[J]. 应用光学, 2004, 25(6): 54-56
9. 陈治平; 陈建设; 陈培彬; 朱岳超; 叶结松. 凝视型电荷耦合器件探测器数学模型[J]. 应用光学, 2005, 26(1): 29-31
10. 黄震; 舒朝濂; 马卫红; 杨利红; 孙国斌. 基于针孔目标物的调制传递函数测试[J]. 应用光学, 2007, 28(4): 504-507
11. 洪汉玉; 喻九阳; 陈以超; 易新建. 红外目标湍流退化图像的优化复原算法[J]. 应用光学, 2006, 27(6): 510-515
12. 宋家军; 何平安. LCoS背投光学引擎中变焦投影物镜设计[J]. 应用光学, 2007, 28(1): 58-62
13. 程丽红^{1,2}; 田晓东¹; 谢存¹. 编码孔径成像系统中的点扩散函数[J]. 应用光学, 2005, 26(5): 13-016
14. 张林^{1,2}; 吴晓琴²; 汤宫民¹. 基于MTF的时间延迟积分CCD成像系统同步误差分析[J]. 应用光学, 2006, 27(2): 167-170
15. 李旭东; 惠渭生; 胡铁力; 付建明. 红外热成像系统调制传递函数(MTF)测试研究[J]. 应用光学, 2006, 27(4): 323-326