

本期目录 | 下期目录 | 过刊浏览 | 高级检索

[打印本页] [关闭]

信息科学

应用属性距离加权平均滤波提高CCD光斑的亚像素定位精度

熊刚, 丁天怀, 王鹏

清华大学 精密仪器与机械学系, 北京 100084

摘要: 针对现有滤波方法无法克服CCD光斑信号的噪声去除和特征保持之间的矛盾, 由图像噪声引起的随机误差成为影响光斑定位精度主要因素的问题, 提出了用属性距离加权平均(ADWA)方法对光斑图像进行滤波处理的方案。根据含噪信号的属性分离信号和噪声, 通过增加属性的方式来进一步缓解噪声去除与信号特征保持之间的矛盾。实验结果表明, 在基于位置、幅值的二元属性距离加权平均(2-ADWA/LV)的基础上, 引入“梯度”属性构成3-ADWA/LVG后对光斑信号进行滤波处理, 能将光斑定位精度提高20%以上, 使定位结果标准差减小到0.024 pixel。实验表明, 用ADWA对光斑信号滤波, 可通过挖掘和引入新的属性来进一步去除光斑信号噪声同时增强信号特征保持效果, 从而为提高光斑的亚像素定位精度提供一条有效途径。

关键词: 电荷耦合器件 亚像素定位 质心 属性距离 噪声去除 特征保持

Improvement of sub-pixel location accuracy of light-spot on CCD with ADWA filter

XIONG Gang, DING Tian-huai, WANG Peng

Department of Precision Instruments and Mechanology, Tsinghua University, Beijing 100084, China.

Abstract: As existing filtering methods could not overcome the contradiction between noise removal and feature preserving for the light-spot signals on a CCD, the random error resulted from image noises has become a key constraint on the location accuracy of the light-spot images. Therefore, a filtering method named Attribute Distance Weighted Average (ADWA) is proposed to denoise the light-spot images. The method separates signals and noises based on their attributes, and alleviates the contradiction between noise removal and feature preserving of the signals progressively through introducing new attributes. Experimental results show that as compared with the bivariate ADWA based on "location" and "value"(2-ADWA/LV), the sub-pixel location accuracy of light-spot has been improved by more than 20% and the standard deviation of location reduced to 0.024 pixel by introducing a 3-ADWA/LVG formed by adding an attribute "gradient" to 2-ADWA/LV. It concludes that when the ADWA is used to denoise the light-spot image, the filtering performance can be further enhanced progressively in both noise removal and feature preserving through introducing new attributes. The ADWA gives a new effective way to further improve the sub-pixel location accuracy of the light-spot.

Keywords: Charge Coupled Device (CCD) sub-pixel location centroid attribute distance noise removal feature preserving

收稿日期 2012-01-28 修回日期 2012-03-01 网络版发布日期 2012-05-10

基金项目:

清华大学校企合作资助项目(No.041514028)

通讯作者: 丁天怀

作者简介: 熊刚 (1973-), 男, 重庆武隆人, 博士研究生, 讲师, 2003年于解放军后勤工程学院获得硕士学位, 主要从事测控技术、信号处理、嵌入式系统方面的研究。E-mail: xiongg07@mails.tsinghua.edu.cn

作者Email: dljn@mail.tsinghua.edu.cn

参考文献:

- [1] WANG X J, GAO J, WANG L. A survey of subpixel object localization for image measurement. *IEEE International Conference on Information Acquisition*, 2004: 398-401. [2] CUI J W, TAN J B, AO L, *et al.*. Optimized algorithm of laser spot center location in strong noise. *Journal of Physics: Conference Series* 13, 2005: 312-315. [3] LIANG B, DONG M L, WANG J. Sub-pixel location of center of target based on Zernike moment [J]. *SPIE*, 2010, 7544: 75443A-1-75443A-6. [4] HOU B K, DING X M. Image segmentation algorithm for location of laser spots during aircraft relative attitude determination. *SPIE*, 2010, 7544: 754415-1-754415-6. [5] XU T F, ZHAO P. Precise center location for light spot contour images of light emitting diode control points in light-pen vision coordinate measurement [J]. *Opt. Precision Eng.*, 2008, 47(12): 123602(1-9). [6] JIA H, YANG J K, LI X J. Minimum variance unbiased subpixel centroid estimation of point image limited by photon shot noise [J]. *J. Opt. Soc. Am. A*, 2010, 27(9): 2038-2045. [7] 陈运锦, 冯莹, 魏立安, 等. 光斑质心亚像素定位误差的实验研究 [J]. *光电工程*, 2010, 37(2): 80-84. CHEN Y J, FENG Y, WEI L A, *et al.*. Experiment research on subpixel location error of the facula centroid [J]. *Opto-Electronic Engineering*, 2010, 37(2): 80-84. (in Chinese) [8] 杨君, 张涛, 宋靖雁, 等. 星点质心亚像素定位的高精度误差补偿法 [J]. *光学精密工程*, 2010, 18(4): 1002-1010. YANG J, ZHANG T, SONG J Y, *et al.*. High accuracy error compensation algorithm for star image sub-pixel subdivision location [J]. *Opt. Precision Eng.*, 2010, 18(4): 1002-1010. (in Chinese) [9] HAGEN N, KUPINSKI M, DERENIAK E L. Gaussian profile estimation in one dimension [J]. *Applied Optics*, 2007, 46(22): 5374-5383. [10] 应家驹, 王永仲, 何永强, 等. 成像激光告警的光斑定位误差分析 [J]. *红外与激光工程*, 2010, 39(3): 431-436. YING J J, WANG Y ZH, HE Y Q, *et al.*. Location error analysis of laser spot in imaging laser warning system [J]. *Infrared and Laser Engineering*, 2010, 39(3): 431-436. (in Chinese) [11] CHEN H L, RAO CH H. Accuracy analysis on centroid estimation algorithm limited by photon noise for point object [J]. *Optics Communications*, 2009, 282(8): 1526-1530. [12] 苗世迪, 乔佩利, 林克正, 等. 基于线阵CCD的精确测量方法研究 [J]. *哈尔滨理工大学学报*, 2006, 11(2): 1-3. MIAO

SH D, QIAO P L, LIN K ZH, *et al.*. Research of method in the precise measurement based on line scan CCD [J]. *J. Harbin Univ. of Science and Technology*, 2006, 11(2): 1-3. (in Chinese) [13] 王志乾,刘兆蓉,赵雁,等. 变形测量系统中激光光斑中心精确定位算法 [J]. 电子测量与仪器学报, 2011, 25(6): 485-489. WANG ZH Q, LIU ZH R, ZHAO Y, *et al.*. Precise center location algorithm for laser spot in distortion measuring system [J]. *J. Electronic Measurement and Instrument*, 2011, 25(6): 485-489. (in Chinese) [11] 张奔牛,万红明,毛成林. 基于差分光斑中心定位算法的位移传感技术研究 [J]. 传感技术学报, 2011, 24(2): 215-219. ZHANG B N, WAN H M, MAO CH L. Study on Displacement Sensor Based on Difference Operation Spot Center Location Algorithm [J]. *Chinese Journal of Sensors and Actuators*, 2011, 24(2): 215-219. (in Chinese) [15] LIU H B, YANG J K, WANG J Q, *et al.*. Star spot location estimation using Kalman filter for star tracker [J]. *Applied Optics*, 2011, 50(12): 1735-1744.

本刊中的类似文章

1. 魏新国 徐佳 张广军. 星敏感器质心定位S曲线误差补偿[J]. 光学精密工程, 2013,21(4): 849-857
2. 吴厚德 许文海. 多输出CCD接缝校正[J]. 光学精密工程, 2013,21(2): 454-461
3. 许文海, 吴厚德. 超高分辨率CCD成像系统的设计[J]. 光学精密工程, 2012,20(7): 1603-1610
4. 任建伟, 张艳琪, 叶钊, 全先荣. CCD辐射响应函数矩阵的建立与应用[J]. 光学精密工程, 2012,20(5): 957-962
5. 刘秉琦, 周斌, 武东生, 张瑜. 双通道激光主动探测系统[J]. 光学精密工程, 2012,20(2): 241-246
6. 谭立英, 吴世臣, 韩琦琦, 马晶. 潜望镜式卫星光通信终端的CCD粗跟踪[J]. 光学精密工程, 2012,20(2): 270-276
7. 付瀚毅, 刘伟奇, 柳华, 魏忠伦, 康玉思, 冯睿, 卢海平, 孙亮. 单一原子氧辐照对SR107-ZK白漆反射率的影响[J]. 光学精密工程, 2012,20(12): 2607-2612
8. 王海涌, 武文卿, 薛晓峰, 赵彦武. 分块峰值点局部区域生长的星像提取[J]. 光学精密工程, 2012,20(11): 2507-2515
9. 王兴玲, 刘龙飞, 于钢, 雷宇, 陶亮. 全球陆地光学遥感影像获取技术与应用[J]. 光学精密工程, 2012,20(10): 2324-2330
10. 樊巧云, 张广军. 离散噪声图像的光斑质心算法及其硬件实现[J]. 光学精密工程, 2011,19(12): 2992-2998
11. 孙瑾秋, 周军, 张臻, 张永鹏. 基于能量累加的空间目标星像质心定位[J]. 光学精密工程, 2011,19(12): 3043-3048
12. 钮赛赛, 沈建新, 梁春, 张运海. 人眼像差探测哈特曼波前传感器的质心优化[J]. 光学精密工程, 2011,19(12): 3016-3024
13. 王德江, 董斌, 李文明, 金灿强. TDI CCD电荷转移对遥感相机成像质量的影响[J]. 光学精密工程, 2011,19(10): 2500-2506
14. 王新升;李葆华;郑靖. 应用有限冲击响应滤波器消除星敏感器星像噪声[J]. 光学精密工程, 2010,18(6): 1381-1386
15. 张达, 徐抒岩. 高速CCD图像数据光纤传输系统[J]. 光学精密工程, 2009,17(3): 669-675

Copyright by 光学精密工程