光学 精密工程
OPTICS AND PRECISION ENGINEERING
核心期刊
主管：中国科学院
主办：中国科学院长春光学精密机械与物理研究所
中国仪器仪表学会
主编：曹健林

光学精密工程 2013, 21(6) 1576-1585 ISSN: 1004-924X CN: 22-1198/TH

信息科学

采用非局部均值的超分辨率重构

贾平[1],李家德[1,2],张叶[1]

1.中国科学院 长春光学精密机械与物理研究所 中国科学院航空光学成像与测量重点实验室 2.中国科学院大学

摘要： 由于传统的超分辨率重构无法在工程应用中对含有局部运动图像进行有效的运动估计及重构，本文提出一种采用非局部均值(NLM)的超分辨率重构方案。简要介绍了具有较好去噪特性的非局部均值滤波器，分析了超分辨率重构的代价函数，根据构造出的非局部均值超分辨率重构算法的代价函数及其求解，对提出的方案进行进一步的优化和化简，最后得到一种易于工程实现的重构算法。实验结果表明，提出的算法不仅具有NLM算法的优点，即不需进行显式的运动估计就能得到更清晰、细节更丰富的重构图像；而且重构速度比简化前的NLM算法提高将近30%，有望应用于具有复杂运动的图像的超分辨率重构。

关键词： 非局部均值 超分辨率 运动估计 滤波器 去噪

Super-resolution reconstruction using nonlocal means

JIA Ping[1],LI Jia-de[1,2],ZHANG Ye[1]

1.Key Laboratory of Airborne Optical Imaging and Measurement, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences 2.University of Chinese Academy of Sciences

Abstract: As conventional super-resolution algorithms can not implement the motion estimation and reconstruction for an image with local motion in practical engineering applications, this paper proposed a super-resolution reconstruction algorithm based on NonLocal Means (NLM). First, the NLM filter, one of the successful denoising filters in recent years, was introduced briefly. Then, the details concerning its application to super-resolution were analyzed by creating a super-resolution cost function. By considering the practical situations and the need of the engineering facet, a scheme to simplify the procedure in the NLM super-resolution algorithm was proposed. The experiment results show that the simplified algorithm can not only effectively implement super-resolution reconstruction to get a clear and detailed image without explicit motion estimation, but also can obtain a reconstructed speed higher 30% than that of conventional algorithms. It can satisfy the practical needs of engineering set-tings and is expected to reconstruct the high resolution image with complex motion.

Keywords: non-local means super-resolution motion estimation filter denoising

收稿日期 2012-04-20 修回日期 2012-06-19 网络版发布日期 2013-06-20

基金项目:

国家自然科学基金青年基金

通讯作者: 李家德

作者简介: 李家德（1987-），男，重庆人，2010年于中国科学技术大学获学士学位，主要从事图像处理、超分辨率重构等方面的研究。

作者Email: ljdsoft2003@163.com

参考文献：

[1]TSAI R Y, HUANG T S. Multiframe image restoration and registration[J]. Advances in Computer Vision and Image Processing,1984,1: 317-339. [2]ELAD M, FEUER A. Restoration of a single superresolution image from several blurred, noisy, and undersampled measured images [J].IEEE Transactions on Image Processing,1997, 6(12): 1646-1658. [3] ELAD M, HEL-OR Y. A fast super-resolution reconstruction algorithm for pure translational motion and common space-invariant blur[C]. Israel,2000:402-405. [4]HARDIE R C, BARNARD K J, ARMSTRONG E E. Joint MAP registration and high-resolution image estimation using a sequence of undersampled images[J]. IEEE Transactions on Image Processing, 1997, 6(12): 1621-1633. [5]RAJAN D, CHAUDHURI S. An MRF-based approach to generation of super-resolution images from blurred observations [J]. Springer Netherlands, 2002,16:5-15. [6]CHEESEMAN P, KANEFSKY B, KRAFT R, et al.. Super-resolved surface reconstruction from multiple images [C]. Santa Barbara, California,1996:293-308. [7]NHAT N, MILANFAR P, GOLUB G. A computationally efficient superresolution image reconstruction algorithm[J]. IEEE Transactions on Image Processing, 2001, 10(4): 573-583. [8]FARSIU S, ROBINSON M D, ELAD M, et al.. Fast and robust multiframe super resolution[J]. IEEE Transactions on Image Processing, 2004, 13(10): 1327-1344. [9]ZOMET A, RAV-ACHA A, PELEG S. Robust super-resolution[C]. Kauai,2001:645-650. [10]ZHANG L, YUAN Q, SHEN H, et al.. Multiframe image super-resolution adapted with local spatial information [J]. Journal of the Optical Society of America A, 2011, 28(3): 381-390. [11]LI X, HU Y, GAO X, et al.. A multi-frame image super-resolution method[J]. Signal Processing, 2010, 90(2): 405-414. [12]PURKAIT P, CHANDA B. Morphologic gain-controlled regularization for edge-preserving super-resolution image reconstruction [J]. Signal, Image and Video Processing,2011: 1-14. [13]JIN C, NUNEZ-YANEZ J, ACHIM A. Video super-resolution using generalized gaussian Markov Random Fields[J]. Signal Processing Letters, IEEE, 2012, 19(2): 63-66. [14]SU H, TANG L, WU Y, et al.. Spatially adaptive block-based super-resolution[J]. IEEE Transactions on Image Processing, 2012, 21(3): 1031-1045. [15]PELLETIER S, COOPERSTOCK J R. Preconditioning for edge-preserving image super resolution[J]. IEEE Transactions on Image Processing, 2012, 21(1): 67-79. [16]SU H, WU Y, ZHOU J. Super-resolution without Dense Flow[J]. IEEE Transactions on Image Processing, 2012,21(4):1782-1795. [17]ARICAN Z, FROSSARD P. Joint registration and super-resolution with omnidirectional images[J]. IEEE Transactions on Image

Processing, 2011, 20(11): 3151-3162. [18]TIAN Y, YAP K, CHEN L. L1-norm multi-frame super-resolution from images with zooming motion[C]. Hangzhou,2011:1-6. [19]PATEL V, MODI C K, PAUNWALA C N, et al.. Hybrid approach for single image super resolution using ISEF and IBP [C]. Katra Jammu，2011:495-499. [20]KELLER S H, LAUZE F, NIELSEN M. Video super-resolution using simultaneous motion and intensity calculations [J]. IEEE Transactions on Image Processing, 2011, 20(7): 1870-1884. [21]姜伟，魏世衡. 反射型立体视觉系统的视差估计和图像复原[J]. 光学 精密工程,2011,19(7):1701-1707. JIANG W, WEI S H. Disparity estimation and image restoration for reflection stereo vision[J]. Opt. Precision Eng., 2011,19(7):1701-1707.(in Chinese) [22]马冬冬，李金宗，朱兵，等. 并行图像复原与超分辨处理系统的设计与实现[J]. 光学 精密工程,2009,17(5):1149-1160. MA D D, LI J Z, ZHU B, et al.. Implementation of parallel image restoration and super -resolution processing system [J]. Opt. Precision Eng., 2009,17(5):1149-1160. [23]徐正平，翟林培，葛文奇，等. 亚像元的CCD几何超分辨方法[J]. 光学 精密工程,2008,16(12):2447-2453. XU Z P, ZHAI L P, GE W Q, et al.. CCD geometric superresolution method based on subpixel[J]. Opt. Precision Eng., 2008,16(12):2447-2453.(in Chinese) [24]MAHMOUDI M, SAPIRO G. Fast image and video denoising via nonlocal means of similar neighborhoods[J]. Signal Processing Letters,2005,12(12):839-842. [25]WANG J, JEON G, JEONG J. Deinterlacing algorithm with an advanced non-local means filter[J]. Optical Engineering,2012,51(4):47009. [26]NERCESSIAN S, PANETTA K A, AGAIAN S S. A multi-scale non-local means algorithm for image de-noising [C]. Baltimore, Maryland,SPIE, 2012:84010J-84060J. [27]BINEV P, BLANCO-SILVA F, BLOM D, et al.. High-quality Image Formation by Nonlocal Means Applied to High-Angle Annular Dark-Field Scanning Transmission Electron Microscopy (HAADF-STEM)[M]. Modeling Nanoscale Imaging in Electron Microscopy, Springer US, 2012. [28]TSCHUMPERL D, BRUN L. Non-Local Regularization and Registration of Multi-Valued Images By PDE’s and Variational Methods on Higher Dimensional Spaces[M]. Mathematical Image Processing, Bergounioux M, Springer Berlin Heidelberg, 2011. [29]XIAOHUA Z, QIANG Z, JIAO L C. Image denoising with non-local means in the shearlet domain[C]. Xiamen, 2011:1-5. [30]YONG S K, HWASUP L, OUK C, et al.. Separable bilateral nonlocal means [C]. Brussels, Belguim, 2011:1513-1516. [31]BUADES A, COLL B, MOREL J M. A non-local algorithm for image denoising[C]. San Diego, 2005:60-65. [32]PROTTER M, ELAD M, TAKEDA H, et al.. Generalizing the nonlocal-means to super-resolution reconstruction [J]. IEEE Transactions on Image Processing, 2009,18(1):36-51. [33]BUADES A, COLL B, MOREL J M. Denoising image sequences does not require motion estimation[C]. Como: 2005:70-74. [34]FARSIU S. Robust shift and add approach to superresolution [J]. Proceedings of SPIE,2003,5203(1):121-130. [35]吴琼. 可见光图像超分辨率客观评价方法研究[D]. 北京: 首都师范大学, 2009. WU Q. Scientific super-resolution objective evaluation index and method system[D]. Beijing: Capital Normal University, 2009.(in Chinese)

本刊中的类似文章

1．吴迪 曹洁 王进花.基于自适应高斯混合模型与静动态听觉特征融合的说话人识别[J]. 光学精密工程, 2013,21(6): 1598-1604

2．鲁怀伟 邬开俊 罗冠炜.双“8”字型全光纤三端口Interleaver[J]. 光学精密工程, 2013,21(4): 889-894

3．吴银花 金龙旭 张宁 张柯 韩双丽 赵运隆 李进.针对H.264快速整像素运动估计算法[J]. 光学精密工程, 2013,21(4): 1017-1025

4．罗玉昆 罗诗途 罗飞路 潘孟春.激光超声信号去噪的经验模态分解实现及改进[J]. 光学精密工程, 2013,21(2): 479-487

5．任文琦 王元全.基于梯度矢量卷积场的四阶各向异性扩散及图像去噪[J]. 光学精密工程, 2013,21(10): 2713-2719

6．赵慧洁，程宣，张颖.用于火星探测的声光可调谐滤波器成像光谱仪[J]. 光学精密工程, 2012,20(9): 1945-1952

7．祝世平，陈菊媕.基于预搜索的高效双目分形视频编码[J]. 光学精密工程, 2012,20(3): 675-684

8．陈传虎，邹德旋，刘海宽.应用统计距离实现虹膜定位[J]. 光学精密工程, 2012,20(11): 2516-2522

9．邱家涛，李玉山，初秀琴，刘洋，倪乐真.稳定运动物体视频的特征方法[J]. 光学精密工程, 2012,20(10): 2300-2307

10．梁帆，孟晓风，董登峰.心脏动脉旁路手术中手术辅助机器人的模型跟随控制[J]. 光学精密工程, 2012,20(1): 131-139

11．张坤，许廷发，王平，冯亮.高精度实时全帧频SURF电子稳像方法[J]. 光学精密工程, 2011,19(8): 1964-1972

12．徐念喜，冯晓国，梁凤超，王岩松，高劲松.对称双屏Butterworth型频率选择表面的设计[J]. 光学精密工程, 2011,19(7): 1486-1494

13．冯肖维，何永义，方明伦，张军高.应用特征估计的距离图像多尺度滤波[J]. 光学精密工程, 2011,19(5): 1118-1125

14．苏学军，高劲松，朱华新，赵晶丽，冯晓国.窄通带高透过频率选择表面[J]. 光学精密工程, 2011,19(3): 561-566

15．周虎，郗继贵，张滋黎，叶声华.激光电子经纬仪动态跟踪引导系统的设计[J]. 光学精密工程, 2011,19(11): 2671-2678