

## 论文

## 去除乘性噪音的主成分分析算法

姚莉丽<sup>1</sup>,冯象初<sup>1</sup>,李亚峰<sup>1,2</sup>(1 西安电子科技大学 应用数学系,西安 710071)  
(2 宝鸡文理学院 计算机科学系,陕西 宝鸡 721007)

## 摘要:

雷达成像系统的进一步应用依赖于对图像中噪音的有效抑制.在目前现有消除噪音方法的基础上,基于图像的局部相似性,结合主成分分析法,提出一种新的有效去除乘性噪音的滤波算法.乘性噪音经对数变换后可转化为加性噪音处理.分析了对数域中噪音的类型.首先在图像的对数域,通过非局部方法选取局部相似块作为训练样本,利用主成分分析法提取出信号的主要特征.然后基于统计理论中最小均方误差估计法给出了一种适用于图像信息的阈值原则.最后分析了变换过程引起的偏差,由对数域的偏估计得到滤波图像.数值实验验证了新算法的有效性.对比于目前提出的变分方法,新算法处理后的图像有更高的信噪比和更好的视觉效果,且具有一定的实用性.

**关键词:** 主成分分析 线性最小均方误差估计 乘性噪音 偏估计

## Principal Component Analysis Method for Multiplicative Noise Removal

YAO Li-li<sup>1</sup>,FENG Xiang-chu<sup>1</sup>,LI Ya-feng<sup>1,2</sup>(1 |Department of Applied Mathematics,Xidian University,Xi'an 710071,China)  
(2 Department of Computer Science,Baoji University of Arts and Science,Baoji,Shaanxi 721007,China)

## Abstract:

The further application of Radar image system relies on the quality of denoising from images.By analyzing the existing denoising algorithms,a new algorithm was presented using principal component analysis for removing multiplicative noise,based on local similarity of images.Multiplicative noise by logarithmic transformation could be converted into the additive noise for processing.Type analysis of the noise in the logarithmic domain was given.In the image logarithm domain,training sample blocks were selected by nonlocal method,and the principal component analysis was used to extract the main features of image blocks.A threshold principle,was proposed by linear minimum mean-square error estimate,which adapted to the signal message.The denoising images were obtained by biased estimation.Experiment results show that the presented method is valid.Compared with the existing variational methods,the new method has higher peak signal to noise ratio and better visual effect.That the performance of the proposed method is practical at a certain extent.

**Keywords:** Principal Component Analysis(PCA) Linear Minimum Mean Square Error Estimate(LMMSE) Multiplicative noise Biased estimate

收稿日期 2011-01-10 修回日期 2011-03-11 网络版发布日期 2011-07-25

DOI: 10.3788/gzxb20114007.1031

## 基金项目:

国家自然科学基金(No.60872138、No.61001156)和宝鸡文理学院2010年院级科研重点项目(No.ZK10171)资助

**通讯作者:** 冯象初(1962-),男,教授,博导,主要研究方向为偏微分方程、小波分析及其在数字图像处理中的应用.

Email:xcfeng@mail.xidian.edu.cn

## 作者简介:

## 参考文献:

- [1]BUADES A,COLL B,MOREL J M.A nonLocal algorithm for image denoising[C].Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition,2005,2:60-65.
- [2]DABOV K,FOI A,KATKOVNIK V,et al.Image denoising by sparse 3D transform-domain collaborative filtering[J].IEEE Transactions on Image Processing,2007,16(8):2080-2095.
- [3]LI Ya-feng,FENG Xiang-chu.The split Bregman method for L1 projection problems[J].Acta Electronica Sinica,2010,38(11):2471-2475. 李亚峰,冯象初.L1投影问题的分裂Bregman方法[J].电子学报,2010,38(11):2471-2475.
- [4]AHARON M,ELAD M,BRUCKSTEIN A M.The K-SVD:an algorithm for designing of overcomplete dictionaries for sparse representation [J].IEEE Transactions on Signal Processing,2006,54(11):4311-4322.
- [5]LEE J S.Speckle suppression and analysis for synthetic aperture radar image[J].Optical Engineering,1986,25(5):636-643.
- [6]KUAN D,SAWCHUK A,STRAND T.Adaptive restoration of image with speckle[J].IEEE Transactions on Acoustics Speech and Signal Processing,1987,35(3):373-383.
- [7]FROST V S,STILES J A,SHANMUGAN K S.A mode for radar image and its application to adaptive digital filtering of multiplicative noise [J].IEEE Transactions on Pattern Analysis and Machine Intelligence,1982,4(2):157-165.
- [8]DONOHO D L,JOHNSTONE I M.Ideal spadal adaptation by wavelet shrinkage[J].Biometrika,1994,81(3):425-455.
- [9]DONOHO D L.Denoising by soft-thresholding[J].IEEE Transaction on Information Theory,1995,41(3):613-627.
- [10]SHI J,OSHER S.A nonlinear inverse scale space method for a convex multiplicative noise model[J].SIAM Journal on Imaging Sciences,2008,1(3):294 - 321.
- [11]AUBERT G,AUJOL J F.A variational approach to removing multiplicative noise[J].SIAM Journal on Applied Mathematics,2008,68(4):925 - 946.
- [12]CHESNEAU C,FADILI J,STARCK J L.Stein block thresholding for image denoising[J].Applied and Computational Harmonic Analysis,2010,28(1):67-88.
- [13]DURAND S,FADILI J,NIKOLOVA M.Multiplicative noise removal using L1 fidelity on frame coefficients[J].Mathematical Imaging and Vision,2010,36(3):201-226.
- [14]KIM K,JUNG K,KIM H J.Face recognition using kernal principle component analysis[J].IEEE Signal Processing Letters,2002,9(2):40-42.
- [15]FARRELL M D Jr,MERSERAU R M.On the impact of PCA dimension reduction for hyperspectral detection of difficult targets [J].Geoscience and Remote Sensing Letters,2005,2(2):192-195.
- [16]ZHANG Lei,DONG Wei-sheng,ZHANG D,et al.Two-stage image denoising by principal component analysis with local pixel grouping [J].Pattern Recognition,2010,43(4):1531 - 1549.
- [17]梁之舜,邓集贤,杨维权,等.概率论及数理统计(下)[M].2版.北京:高等教育出版社,1992:95-97.
- [18]梁昆淼.数学物理方法[M].2版.北京:人民教育出版社,1978:554-560.

## 本刊中的类似文章

1. 魏坤 赵永强 高仕博 潘泉 张洪才.基于混合概率核主成分二次相关红外目标检测[J].光子学报,2008,37(9):1883-1889
2. 王玉田 张艳林.基于三维荧光光谱特征分析的油种鉴别技术的研究 [J].光子学报,2010,39(7):1330-1333
3. 赵春晖,胡春梅,包玉刚.一种背景误差累积的高光谱图像异常检测算法[J].光子学报,2010,39(10):1830-1835

文章评论 (请注意:本站实行文责自负,请不要发表与学术无关的内容!评论内容不代表本站观点.)

## 扩展功能

本文信息

- ▶ Supporting info
- ▶ PDF(1357KB)
- ▶ HTML
- ▶ 参考文献

## 服务与反馈

- ▶ 把本文推荐给朋友
- ▶ 加入我的书架
- ▶ 加入引用管理器
- ▶ 引用本文
- ▶ Email Alert
- ▶ 文章反馈
- ▶ 浏览反馈信息

## 本文关键词相关文章

- ▶ 主成分分析
- ▶ 线性最小均方误差估计
- ▶ 乘性噪音
- ▶ 偏估计

## 本文作者相关文章

- ▶ 姚莉丽
- ▶ 冯象初
- ▶ 李亚峰

反馈人	<input type="text"/>	邮箱地址	<input type="text"/>
反馈标题	<input type="text"/>	验证码	<input type="text" value="8859"/>
反馈内容	<input type="text"/>		
<input type="button" value="提交"/>			