- Published: 12 June 2021

Low intensity visual data improvement using DWT and LWT based regularizer

- Jyothula Sunil Kumar ✉ &
- T Jaya Chandra Prasad

Multimedia Tools and Applications **80**, 28829–28855 (2021)

Abstract

Image Completion plays a vital role in compressed sensing, machine learning, and computer vision applications. The Rank Minimization algorithms are used to perform the image completion. The major problem with rank minimization algorithms is the loss of information in the recovered image at high corruption ratios. To overcome this problem Lifting wavelet transform based Rank Minimization (LwRM), and Discrete wavelet transform based

Rank Minimization (DwRM) methods are proposed, which can recover the image, if the corrupted observations are more than 80%. The evaluation of the proposed methods are accomplished by Full Reference Image Quality Assessment (FRIQA) and No Reference Image Quality Assessment (NR-IQA) metrics. The simulation results of proposed methods are superior to state-of-the-art methods.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

References

1. 1.
   Afonso M, Bioucas-Dias J, Figueiredo M (Apr. 2010) Fast image recovery using variable splitting and constrained optimization. IEEE transactions on image processing: a publication of the IEEE Signal Processing Society 19:2345–2356. https://doi.org/10.1109/TIP.2010.2047910

2. 2.
Almansa A et al (Jan. 2008) A TV Based Restoration Model with Local Constraints. Journal of Scientific Computing 34:209–236. https://doi.org/10.1007/s10915-007-9160-x

3. 3.
Cai J, Candès EJ, Shen Z (2010). “A singular value thresholding algorithm for matrix completion”. In: SIAM Journal on optimization 20.4, pp. 1956–1982. doi: 10 . 1137 / 080738970. url: https://doi.org/10.1137/080738970

4. 4.
Candès E, Recht B (Nov. 2008) Exact matrix completion via convex optimization. Commun ACM 9:717–772. https://doi.org/10.1007/s10208-009-9045-5

5. 5.
Chen XW et al (2014) Structure guided texture inpainting through multi-scale patches and global optimization for image completion. Science China Information Sciences 57(1):1–16

6. 6.
Cheng G et al (2010). “Perceptual image quality assessment using a geometric structural distortion model”. In: 2010 IEEE International Conference on Image Processing. IEEE, pp. 325–328.

7. 7.
Dai Y, Li H (2014). “Rank minimization or nuclearnorm minimization: Are we solving the

right problem?” In: 2014 International Conference on Digital Image Computing: Techniques and Applications (DICTA). IEEE, pp. 1–8

8. 8.
Dang TT, Beghdadi A, Larabi M-C (2014) A perceptual image completion approach based on a hierarchical optimization scheme. Signal processing 103:127–141

9. 9.
Daubechies I (1992). Ten Lectures on Wavelets. USA: Society for Industrial and Applied Mathematics. isbn: 0898712742.

10. 10.
Daubechies I, Sweldens W (1998) Factoring wavelet transforms into lifting steps. Journal of Fourier analysis and applications 4(3):247–269

11. 11.
Diekerhof M, Monti A, Schwarz S (2018). “Demand-side management—recent aspects and challenges of optimization for an efficient and robust demand-side management”. In: Classical and Recent Aspects of Power System Optimization. Elsevier, pp. 331–360.

12. 12.
Fu Y, Wang S (2016) A no reference image quality assessment metric based on visual perception. In: Algorithms 9(4):87

13. 13.

Golbabaee, Mohammad and Pierre Vandergheynst (Sept. 2012). “Joint trace/TV norm minimization: A new efficient approach for spectral compressive imaging”. In: pp. 933–936. isbn: 978–1–4673-2534-9. doi: https://doi.org/10.1109/ICIP.2012.6467014.

14. 14.
Gonzalez RC, Woods RE (2018). Digital Image Processing (4th Edition). London, England: Pearson. isbn: 9780133356724

15. 15.
Gu S et al. (2017). “Weighted Nuclear Norm Minimization and Its Applications to Low Level Vision”. In: International Journal of Computer Vision 121. doi: https://doi.org/10.1007/s11263-016-0930-5

16. 16.
Han X et al. (2014). “Linear Total Variation Approximate Regularized Nuclear Norm Optimization for Matrix Completion”. In: Abstract and Applied Analysis 2014. doi: https://doi.org/10.1155/2014/765782.

17. 17.
Hu Y, Zhang D, Ye J, Li X, He X (Sept. 2013) Fast and accurate matrix completion via truncated nuclear norm regularization. IEEE Trans Pattern Anal Mach Intell 35:2117–2130. https://doi.org/10.1109/TPAMI.2012.271

18. 18.
Larson E, Chandler D (2010). “Most apparent distortion: Full-reference image quality

assessment and the role of strategy". In: J. Electronic Imaging 19, p. 011006. doi: https://doi.org/10.1117/1.3267105.

19. 19.
Li, Yan-Ran, Lixin Shen, and Bruce W Suter (2012). "Adaptive inpainting algorithm based on DCT induced wavelet regularization". In: IEEE transactions on image processing 22.2, pp. 752–763.

20. 20.
Liu Q et al (Dec. 2015) A Truncated Nuclear Norm Regularization Method Based on Weighted Residual Error for Matrix Completion. IEEE Transactions on Image Processing 25:1–1. https://doi.org/10.1109/TIP.2015.2503238

21. 21.
Mittal A, Moorthy AK, Bovik AC (2012) No-reference image quality assessment in the spatial domain. IEEE Transactions on image processing 21(12):4695–4708

22. 22.
Nesterov Y (2007a). "Gradient methods for minimizing composite objective function Technical Report". In: Center for Operations Research and Econometrics (CORE), Catholic University of Louvain.

23. 23.
Nesterov Y (2007b). "Gradient methods for minimizing composite objective function

(technical report 2007/76)". In: CORE, Université catholique de Louvain

24. 24.
Recht B, Xu W, Hassibi B (2008). "Necessary and sufficient conditions for success of the nuclear norm heuristic for rank minimization". In: 2008 47th IEEE conference on decision and control. IEEE, pp 3065–3070

25. 25.
Sheikh HR (2005). "LIVE image quality assessment database release 2". In: http://live.ece.utexas.Edu/research/quality

26. 26.
Wang J et al (2014) Robust object removal with an exemplar-based image inpainting approach. Neurocomputing 123:150–155

27. 27.
Wang Y, Xu C, You S, Xu C, Tao D (2017) DCT regularized extreme visual recovery. IEEE Trans Image Process 26(7):3360–3371

28. 28.
Xue S et al. (2019). "Double Weighted Truncated Nuclear Norm Regularization for Low-Rank Matrix Completion". In:

29. 29.
Zarif S, Faye I, Rohaya D (2015) Image completion: Survey and comparative study. In: International Journal of Pattern Recognition and Artificial Intelligence 29(03):1554001

30. 30.
Zhang D et al. (2012). “Matrix completion by Truncated Nuclear Norm Regularization”. In: pp. 2192–2199. isbn: 978–1–4673-1226-4. doi: https://doi.org/10.1109/CVPR.2012.6247927

Author information

Affiliations

1. Department of Electronics and Communication Engineering, JNTUA, Anantapur, Andhra Pradesh, India

   Jyothula Sunil Kumar

2. Department of Electronics and Communication Engineering, Rajeev Gandhi Memorial College of Engineering and Technology, Affiliated to JNTUA, Nandyal, Andhra Pradesh, India

   T Jaya Chandra Prasad

Corresponding author

Correspondence to Jyothula Sunil Kumar.

Additional information

Publisher’s note

Rights and permissions

Reprints and Permissions

About this article

Cite this article

Kumar, J.S., Prasad, T.J.C. Low intensity visual data improvement using DWT and LWT based regularizer. *Multimed Tools Appl* **80,** 28829–28855 (2021). https://doi.org/10.1007/s11042-021-11151-0

- Received15 April 2020
- Revised26 January 2021
- Accepted03 June 2021
- Published12 June 2021
- Issue DateAugust 2021
- DOIhttps://doi.org/10.1007/s11042-021-11151-0

Keywords

- Image completion
- Rank minimization
- Lifting wavelet transformation
- Transformation based optimization