# **Image super resolution using variational methods**

# **1.Modified non-local means for super-resolution of hybrid videos**

**Authors:** Yawei Li ,  Xiaofeng Li ,  Zhizhong Fu .

**Review:**

Hybrid movies with periodic low-resolution (LR) and high-resolution (HR) guide frames are commonly used to examine bandwidth efficiency and the tradeoff between spatial and temporal resolution. To enhance the LR frames, super-resolution (SR) techniques are required, with non-local means (NLM) being a promising algorithm. Based on non-local self-similarity between pixels, NLM substitutes each pixel with a weighted average of its neighbours. The fixed fading factor of NLM, on the other hand, cannot meet areas with unique features in LR frames. The fixed neighbourhood, also known as the searching window, fails to reconcile the needs for inexpensive computation and enhanced video quality. We present unique criteria for choosing parameters adaptively in this work. The decaying factor is defined by a pixel's patch difference.The fading factor is defined by a pixel's patch difference and ensures that NLM finds relevant pixels. To estimate the neighbourhood size, two approaches are proposed: a predetermined method inspired by motion estimation and an exhaustive method based on finding increasingly bigger neighbourhoods.

**References:**

1 . [Allebach, Wong, 1996](https://www.sciencedirect.com/science/article/pii/S1077314217302023#bbib0001)J. Allebach, P.W. Wong

Edge-directed interpolation

Proc. IEEE International Conference on Image Processing, 3 (1996), pp. 707-710

# **2.Simultaneous deconvolution and denoising using a second order variational approach applied to image super resolution**

**Authors:** Amine Laghrib , Said Raghay,  Pascal Monasse, Abdelilah Hakim

**Review:**

A Super resolution (SR) technique's goal is to create a high-resolution image from a series of low-resolution images of the same scene. The removal of noise and blur without breaking edges is a fundamental challenge in SR reconstruction. Using a controllable weighting parameter, we offer a unique multiframe picture SR technique based on a convex combination of Bilateral Total Variation and a non-smooth second order variational regularisation. We demonstrate the existence of a minimizer of the suggested energy in the space of bounded Hessian functions. A quick primal-dual technique is used to minimise the convex functional. The simulation results and real-world testing demonstrate the suggested algorithm's performance in avoiding undesired artefacts when compared to existing approaches in the literature.

**References:**

1. [Bergounioux, Piffet, 2010](https://www.sciencedirect.com/science/article/pii/S107731421730142X?casa_token=4vEd9kgpGjUAAAAA:hJ6qDHpFiYZWLJ7KytTAh7cEI82zukG0KKdRUIRcpDziG-_VhgTAgkNPkCPUHN7_ZNhHwKOvfdg#bbib0003) M. Bergounioux, L. Piffet A second-order model for image denoising

Set-Valued Var. Anal., 18 (3–4) (2010), pp. 277-306

2**.** B[redies, Kunisch, Pock, 2010](https://www.sciencedirect.com/science/article/pii/S107731421730142X?casa_token=4vEd9kgpGjUAAAAA:hJ6qDHpFiYZWLJ7KytTAh7cEI82zukG0KKdRUIRcpDziG-_VhgTAgkNPkCPUHN7_ZNhHwKOvfdg#bbib0004)K. Bredies, K. Kunisch, T. Pock

Total generalized variation

SIAM J. Imaging Sci., 3 (3) (2010), pp. 492-526

# **3.ATGV-Net: Accurate Depth Super-Resolution**

**Authors:** [Matthias Rüther](https://link.springer.com/chapter/10.1007/978-3-319-46487-9_17#auth-Matthias-R_ther) &  [Horst Bischof](https://link.springer.com/chapter/10.1007/978-3-319-46487-9_17#auth-Horst-Bischof) , [Gernot Riegle](https://link.springer.com/chapter/10.1007/978-3-319-46487-9_17#auth-Gernot-Riegler)r

**Review:**

In this paper, we describe a unique method for super-resolving single depth maps. Consumer depth sensors, particularly Time-of-Flight sensors, generate dense depth data but suffer from noise and have a limited lateral resolution. We present a method for recovering reliable high-resolution depth maps that combines the benefits of current breakthroughs in machine learning-based single image super-resolution, namely deep convolutional networks, with a variational method. We specifically incorporate a variational technique on top of a deep network that models the piecewise affine structures visible in depth data via an anisotropic total generalised variation regularisation term. We call our technique ATGV-Net and train it from start to finish by unrolling the variational method's optimisation phase. A vast corpus of training data with reliable ground-truth is necessary to train deep networks. We show that we can train our technique exclusively on synthetic data generated in vast amounts for this assignment. Our tests indicate that we achieve state-of-the-art performance on three separate benchmarks, as well as a difficult Time-of-Flight dataset, all without the need of an additional intensity image as guidance.

**References:**

1. Aodha, O.M., Campbell, N.D., Nair, A., Brostow, G.J.: Patch based synthesis for single depth image super-resolution. In: European Conference on Computer Vision (ECCV) (2012).
2. Bredies, K., Kunisch, K., Pock, T.: Total generalized variation. SIAM J. Imaging Sci. **3**(3), 492–526 (2010).

# **4.Total variation super resolution using a variational approach**

**Authors:** [S. Derin Babacan](https://ieeexplore.ieee.org/author/37395152700); [Rafael Molina](https://ieeexplore.ieee.org/author/37281601900); [Aggelos K. Katsaggelos](https://ieeexplore.ieee.org/author/37276769200)

**Review:**

In this research, we offer a new super resolution approach based on total variation priors and variational distribution approximations. The challenge is solved using a hierarchical Bayesian model in which the reconstructed high resolution picture and model parameters are computed concurrently from low resolution data. This formulation's technique employs variational inference and offers approximations to the posterior distributions of the latent variables. The approach is totally automated because of the simultaneous parameter estimates, therefore no parameter adjustment is necessary. The experimental findings reveal that the suggested method beats some of the most advanced super resolution methods.

**References:**

1.A. K. Katsaggelos, R. Molina, and J. Mateos, Super Resolution of Images and Video, Morgan and Claypool, 2007.

2. T. F. Chan, N. Ng, A. Yau, and A. Yip, "Superresolution image reconstruction using fast inpainting algorithms," Applied and Computational Harmonic Analysis, vol

# **5.Fractional differential and variational method for image fusion and super-resolution**

# **Authors:** Zhengtao Yu , Cunli Mao, panelHuafeng Li

**Review:**

This study presents a unique fractional differential and variational model with fusion and super-resolution terms, edge enhancement, and noise suppression. The structure tensor is used in image fusion and super-resolution to represent the geometry of all input pictures. The energy functional of image fusion and super-resolution is established by combining the down-sampling operator with the assumption that the fused picture and the source inputs should have the same or comparable structure tensor. To improve the visualisation of the fused picture, the bidirectional diffusion term is introduced into the image fusion and super-resolution model. In the noise suppression term, a new variational model based on fractional differential and fractional total variation is constructed. Because of the three terms mentioned above, the suggested model can perform image fusion, super-resolution, and edge information improvement all at the same time. To find the best solution, a gradient descent iteration strategy built from the proposed model's Euler-Lagrange equation is used. The numerical findings show that the suggested strategy is both practical and efficient.

**References:**

1.G. Pajares, J. Cruz

A wavelet-based image fusion tutorial

Pattern Recognit., 37 (9) (2004), pp. 1855-1872

2. H. Li, B.S. Manjunath, S.K. Mitra Multisensor image fusion using the wavelet transform.

Graph. Models Image Process., 57 (3) (1995), pp. 235-245

**6.Variational AutoEncoder for Reference Based Image Super-Resolution**

**Authors:**Zhi-Song Liu, Wan-Chi Siu, Li-Wen Wang .

**Review:**

We provide a unique reference-based picture super-resolution technique using Variational AutoEncoder in this study. Existing state-of-the-art solutions mostly focus on single picture super-resolution, which is inefficient at large upsampling values, such as 8x. We present a reference-based picture super-resolution method in which any arbitrary image may serve as a super-resolution reference. The suggested RefVAE may transfer information from the reference to the super-resolved pictures even when utilising a random map or a low-resolution image. The suggested approach may create distinct versions of super-resolved pictures from a concealed super-resolution space based on different references. We participated in the NTIRE2021 SR Space competition and submitted results of the randomness evaluation of our technique, in addition to employing different datasets for some conventional evaluations with PSNR and SSIM. When compared to other cutting-edge approaches, our methodology obtains greater diversity ratings.

References:

1. Yuval Bahat and Tomer Michaeli. Explorable super resolution. In CVPR, pages 2713–2722. IEEE, 2020
2. Y. Blau and T. Michaeli. The perception-distortion tradeoff. In 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition, pages 6228–6237, 2018.

**7.Temporal Super Resolution Using Variational Methods**

**Authors:**Sune Høgild Keller, Franc¸ois Lauze, and Mads Nielsen

**Review:**

The capacity to transform video from one frame rate to another is known as temporal super resolution (TSR), and it is a critical feature in current video processing systems. For high frame rate displays, super slow-motion, and video/film format conversion (where lower frame rates than recorded are often necessary), a greater frame rate than what is recorded is desirable. We explain and describe the criteria imposed by the human visual system (HVS) on TSR algorithms, the most important of which is the necessity for (apparent) fluid motion, commonly known as the phi-effect. This issue is most noticeable while watching video on big and bright monitors, when the motion of high contrast borders appears choppy and unnatural. We offer a unique motion compensated (MC) TSR technique that employs variational approaches for both optic flow computation and real new frame interpolation.In a multiresolution configuration, the flow and intensities are estimated concurrently.We have created a frame doubling version of our technique and are testing it to make the motion of high contrast edges appear smooth and hence reinstate the illusion of motion movies.

**References:**

1. Sivic, J., Zisserman, A.: Video google: a text retrieval approach to obejct matching in videos. In: Proc. of Ninth IEEE International Conference on Computer Vision, pp. 1470– 1477 (2003).
2. Davis, M.: An iconic visual language for video annotation. In: Proc. of IEEE Symposium on Visual Language, pp. 196–202 (1993)

# **8.SRDiff: Single image super-resolution with diffusion probabilistic models**

**Authors:** Haoying Li , Yifan Yang , Meng Chang , Shiqi Chen , Huajun Feng

**Review:**

The goal of single image super-resolution (SISR) is to recreate high-resolution (HR) pictures from low-resolution (LR) photos. Because one LR image correlates to several HR photos, the problem is ill-posed. Learning-based SISR algorithms have recently surpassed classical approaches significantly. However, over-smoothing, mode collapse, and huge model footprint concerns plague PSNR-oriented, GAN-driven, and flow-based techniques, respectively. To address these issues, we offer a novel SISR diffusion probabilistic model (SRDiff), the first SISR diffusion-based model. SRDiff is optimised with a variational constraint on the data likelihood. It may give various and realistic super-resolution (SR) predictions via a Markov chain by progressively converting Gaussian noise into a super-resolution picture conditioned on an LR input. Furthermore, we use residual prediction across the framework to accelerate model convergence. Our extensive experiments on facial and general benchmarks (CelebA and DIV2K datasets) show that (1) SRDiff can generate diverse SR results with rich details and achieve competitive performance against other state-of-the-art methods when given only one LR input; (2) SRDiff is easy to train with a small footprint (The word "footprint" in this paper represents "model size" (number of model parameters).

References:

1.C. Fookes, F. Lin, V. Chandran, S. Sridharan

Evaluation of image resolution and super-resolution on face recognition performance

Journal of Visual Communication and Image Representation, 23 (1) (2012), pp. 75-93

# **9.Amortised MAP Inference for Image Super-resolution**

**Authors:**[Casper Kaae Sønderby](https://arxiv.org/search/cs?searchtype=author&query=S%C3%B8nderby%2C+C+K), [Jose Caballero](https://arxiv.org/search/cs?searchtype=author&query=Caballero%2C+J), [Lucas Theis](https://arxiv.org/search/cs?searchtype=author&query=Theis%2C+L), [Wenzhe Shi](https://arxiv.org/search/cs?searchtype=author&query=Shi%2C+W), [Ferenc Huszár](https://arxiv.org/search/cs?searchtype=author&query=Husz%C3%A1r%2C+F).

**Review:**

Image super-resolution (SR) is an inverse issue with an unknown solution in which a large number of plausible high-resolution pictures may explain the same downsampled image. The majority of contemporary single picture SR approaches employ empirical risk minimization, frequently with a pixel-wise mean squared error (MSE) loss. However, the results of such procedures are hazy, over-smoothed, and look improbable. A better strategy would be to use Maximum a Posteriori (MAP) inference, which favours solutions that have a high probability under the image prior and so look more believable. Direct MAP estimation for SR is difficult since it needs us to construct a model for the image prior from samples. Furthermore, MAP inference is frequently accomplished using iterative optimisation-based methods that fall short of the efficiency of neural-network-based alternatives. We provide novel approaches for amortised MAP inference in which the MAP estimate is directly calculated using a convolutional neural network. We begin by introducing a unique neural network design that conducts a projection to the affine subspace of valid SR solutions, ensuring that the network's high resolution output is always compatible with the low resolution input. Using this architecture, we show that the amortised MAP inference issue is reduced to decreasing the cross-entropy between two distributions, which is analogous to training generative models.

**References:**

* [NASA ADS](https://ui.adsabs.harvard.edu/abs/arXiv:1610.04490).
* [Google Scholar](https://scholar.google.com/scholar_lookup?arxiv_id=1610.04490).
* [Semantic Scholar](https://api.semanticscholar.org/arXiv:1610.04490).

# **10.Hyperspectral Image Super-Resolution With Mosaic RGB Image.**

**Authors:** [Ying Fu](https://ieeexplore.ieee.org/author/37085501174) , [Yinqiang Zheng](https://ieeexplore.ieee.org/author/37085385979); [Hua Huang](https://ieeexplore.ieee.org/author/37085485665) , [Imari Sato](https://ieeexplore.ieee.org/author/37266733600); [Yoichi Sato](https://ieeexplore.ieee.org/author/37276345600)

**Review:**

Many hyperspectral (HS) image super-resolution approaches have recently been presented in spectral imaging, which combine a low spatial resolution HS picture with a high spatial resolution three-channel RGB image. Most contemporary commercial RGB cameras record high quality images with a single CCD/CMOS sensor fitted with a colour filter array, which is a widely overlooked feature. We account for the common imaging process of commercial RGB cameras in this study and suggest using a mosaic RGB picture for HS image super-resolution, which eliminates demosaicing mistake and hence its propagation into the HS image super-resolution results. We develop a proper non-local low-rank regularisation to take advantage of the intrinsic properties-rich self-repeating patterns and high correlation across spectra-within HS images of natural scenes, and we formulate the HS image super-resolution task as a variational optimisation problem that can be efficiently solved using the alternating direction method of multipliers. The suggested method's efficacy was examined on two benchmark data sets, revealing that it can give a significant improvement over current state-of-the-art HS picture super-resolution approaches without taking the mosaicing impact into account. Finally, we demonstrate that our technique works effectively in a real-world capture system.

**References:**

1. M. Borengasser, W. S. Hungate and R. Watkins, Hyperspectral Remote Sensing: Principles and Applications, Boca Raton, FL, USA:CRC Press, 2007.
2. L. Ojha et al., "Spectral evidence for hydrated salts in recurring slope lineae on Mars", Nature Geosci., vol. 8, pp. 829-832, Sep. 2015.
3. T. Vo-Dinh, Biomedical Photonics Handbook: Biomedical Diagnostics, Boca Raton, FL, USA:CRC Press, 2014.