

Image Deblurring – white paper

March 2022

The logo for Saiwa, featuring the word "saiwa" in a lowercase, white, sans-serif font. A thin green horizontal line is positioned directly beneath the text. To the left of the text, there is a thick, solid green diagonal bar that extends from the bottom left towards the center of the page.

saiwa

simple artificial intelligence web application



Image Deblurring is a sub-category of image restoration which is about restoring clean images by removing distortions. One kind of distortion is blurring artifacts. There are several common causes of blurring artifacts in images: camera movement, subject movement, out-of-focus optics, scattered light distortion, insufficient depth of field, and lens softness. Deblurring is about recovering a sharp image from a blurred input, and is inherently an inverse problem and hence does not have one unique solution; that is, it is an ill-posed problem.

Image Deblurring

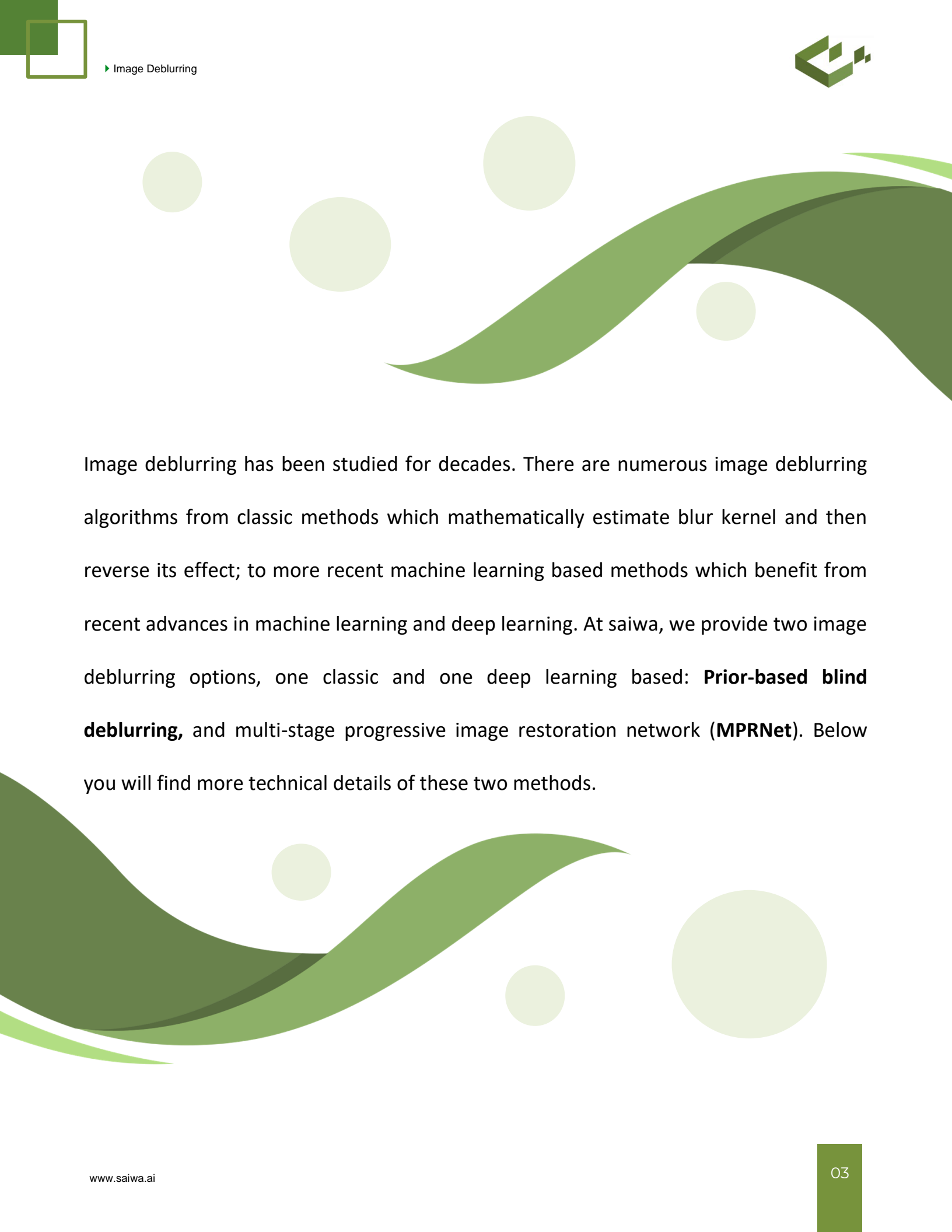


Image deblurring has been studied for decades. There are numerous image deblurring algorithms from classic methods which mathematically estimate blur kernel and then reverse its effect; to more recent machine learning based methods which benefit from recent advances in machine learning and deep learning. At saiwa, we provide two image deblurring options, one classic and one deep learning based: **Prior-based blind deblurring**, and multi-stage progressive image restoration network (**MPRNet**). Below you will find more technical details of these two methods.

Prior-based blind deblurring refers to a blind kernel estimation and deblurring method based on the ℓ_0 gradient prior. The first step of the method is to estimate the blur kernel by alternating between a sharp image prediction using the ℓ_0 prior on the gradient image and a kernel estimation in a multi-scale manner. Once the kernel is estimated, a sharp image is predicted using a standard non-blind deconvolution method and the estimated kernel from previous stage. For more mathematical details of the method, please refer to [1].



Figure 1 shows a few instances of blurry images and the deblurring results from prior-based blind deblurring using saiwa demo interface.



Figure 1. Subjective deblurring results of Prior-based Blind Deblurring method and using saiwa online demo.



Image Deblurring

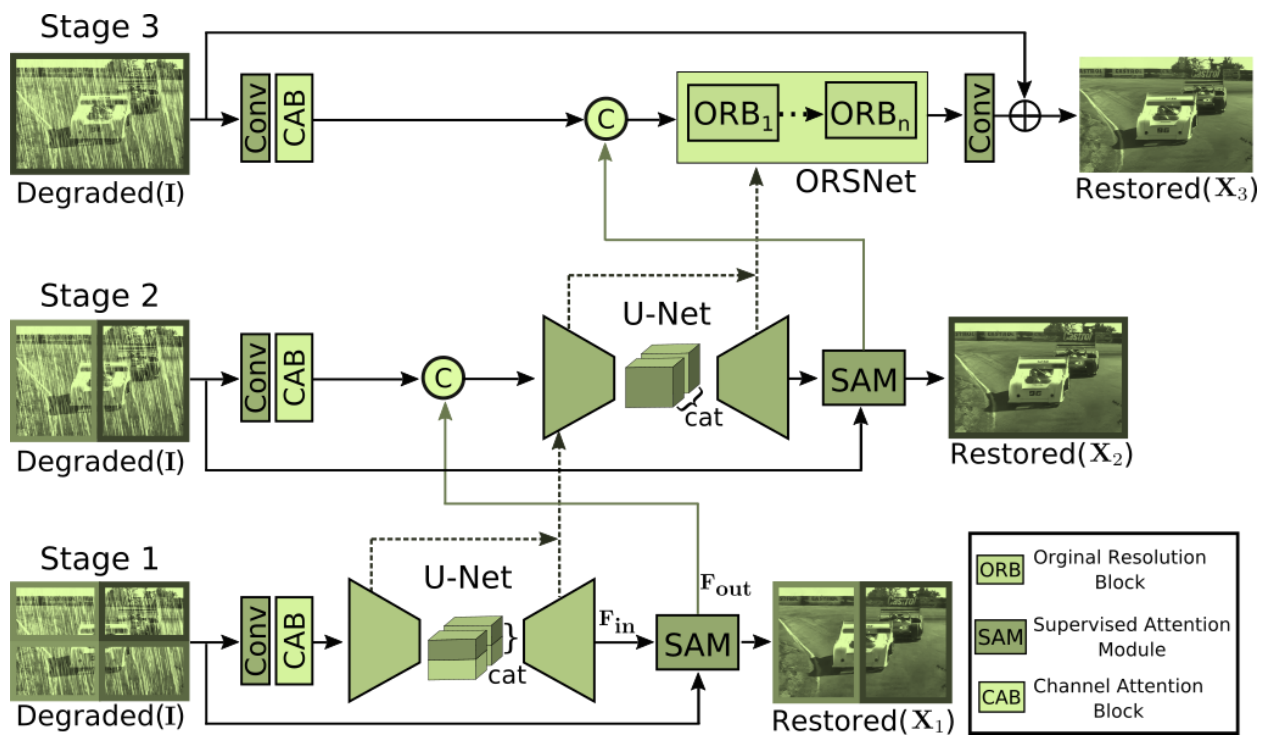


Figure 2. Multi-stage architecture for progressive image restoration of MPRNet (printed from [2])

The second deblurring algorithm provided by saiwa is multi-stage progressive image restoration network (**MPRNet**). MPRNet is a three-stage CNN (convolutional neural network) for image restoration. It has been shown that MPRNet provides high performance gains on several datasets for a range of image restoration problems, such as: image deraining, deblurring, and denoising [2].

The three-stage structure of MPRNet shown in Figure 2 provides several key features:

1. An encoder-decoder for learning multi-scale contextual information in the first two stages
2. Preservation of fine spatial details of the input image by operating on the original image resolution in the last stage
3. A supervised attention module (SAM) that enables progressive learning
4. Cross-stage feature fusion (CSFF) to propagate multi-scale contextualized features from early to late stage.



For technical details of the MPRNet architecture please refer to [2]. Figure 3 shows a few instances of image deblurring using MPRNet method and saiwa Deblurring service interface. We use an open-source implementation of MPRNet that is suggested by the original paper [3].



Figure 3. Subjective deblurring results of MPRNet and using saiwa online demo.



References:

[1] Anger, Jérémy, Gabriele Facciolo, and Mauricio Delbracio. "Blind image deblurring using the I0 gradient prior." Image processing on line 9 (2019): 124-142.

[2] Zamir, Syed Waqas, et al. "Multi-stage progressive image restoration." Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2021.

[3] <https://github.com/swz30/MPRNet>.



info@saiwa.ai

720 Guelph Line Burlington, ON L7R 4E2 Building

+15148131809

www.linkedin.com/company/saiwa

www.instagram.com/saiwa.ai