Hypernetwork-based Adaptive Image Restoration

Shai Aharon and Gil Ben-Artzi

ifryed@gmail.com http://www.gil-ba.com

ARIEL UNIVERSITY

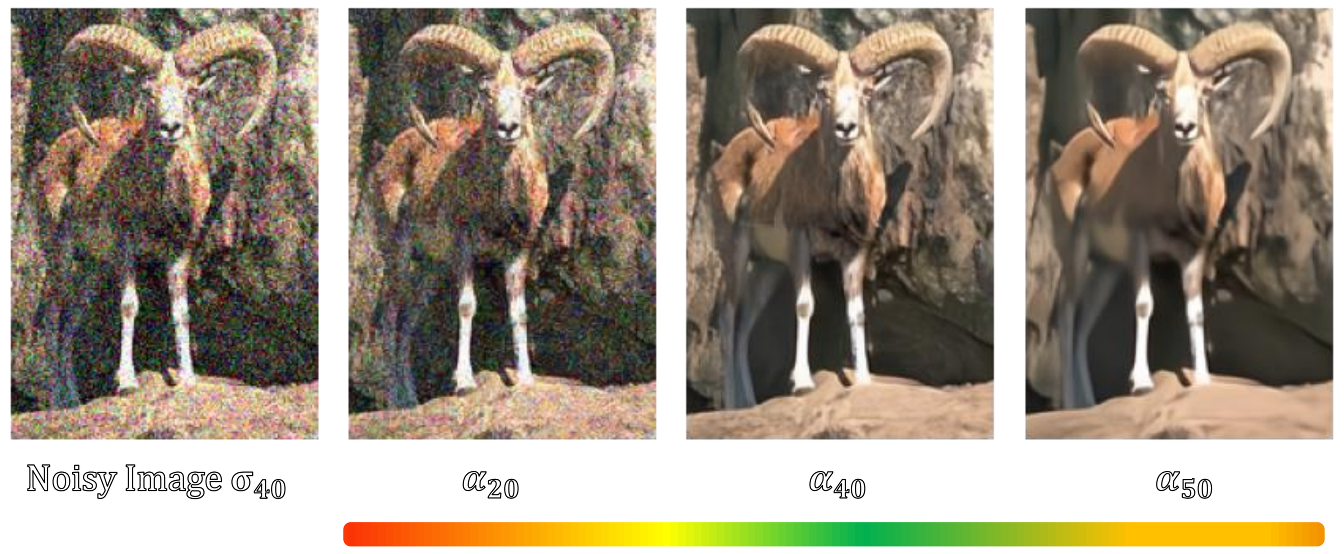
ICASSP 2023
4-10 JUNE, RHODES ISLAND, GREECE

Introduction

Goal Restoring multiple degradation levels

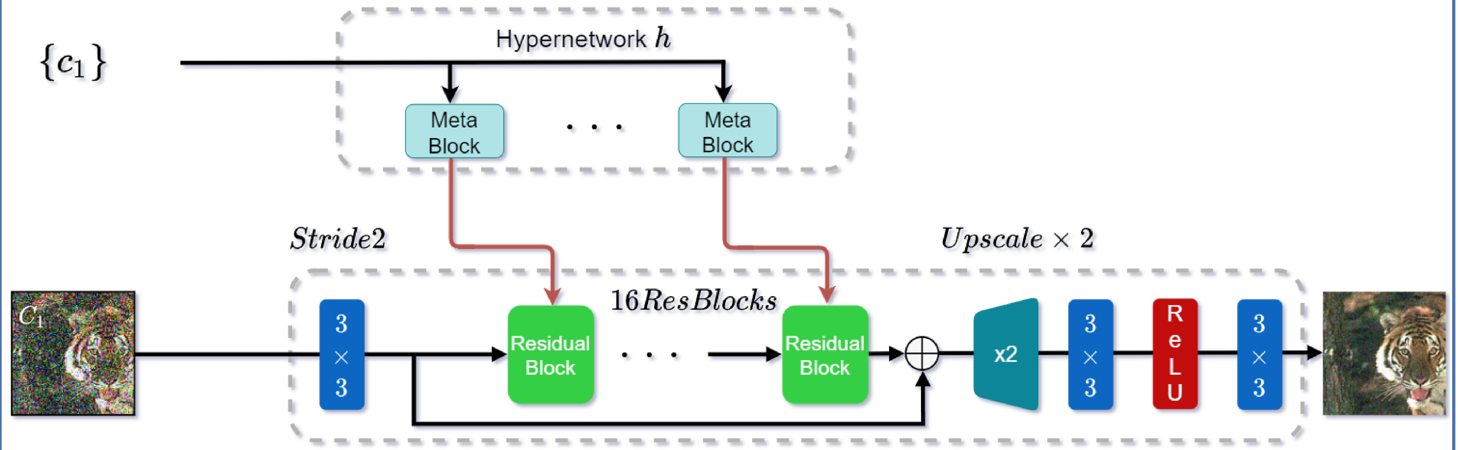
Tasks Denoising
DeJPEG
Super-Resolution
Etc..

Challenge Achieve a high restoration accuracy while maintaining a compact network



Key Idea

We introduce a hypernetwork that generates the optimal kernels for an image restoration network, based on the required restoration level given as an input parameter.



Theory

Observation:

- For a given network architecture, $N_\theta(\cdot)$, there are infinite sets of weights which provide the same or similar output
- Our method finds a set of weights, each corresponding to a different noise level, such that they are linearly depended.
- All set of weights are easily generated from one single set by a simple scalar multiplication.
- $\forall i,j \; s.t. \; \frac{\theta_i}{\theta_j} \propto \frac{i}{j}$

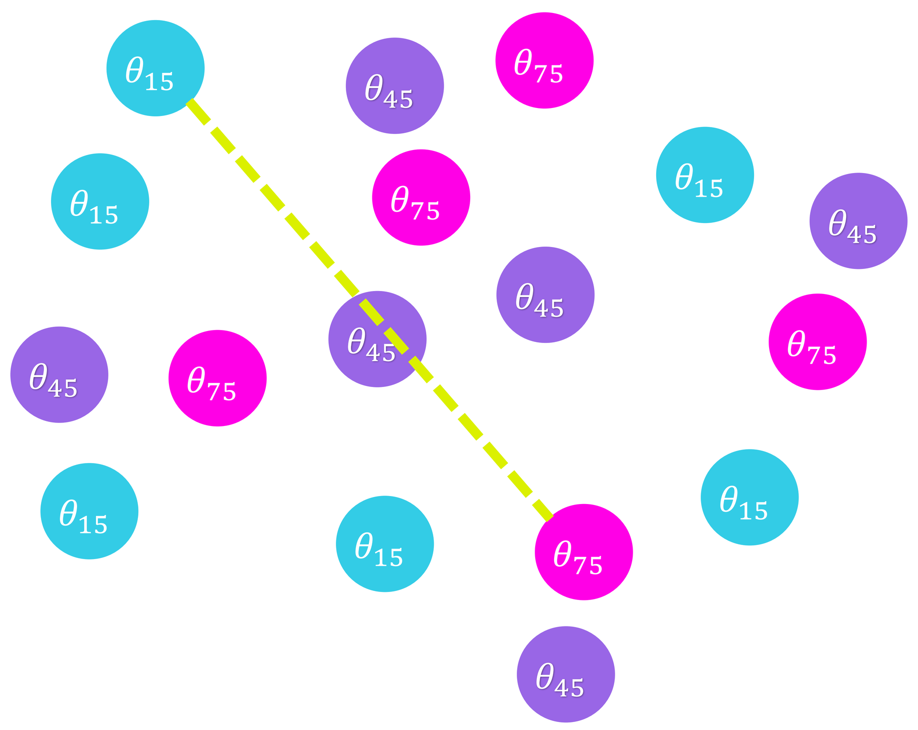
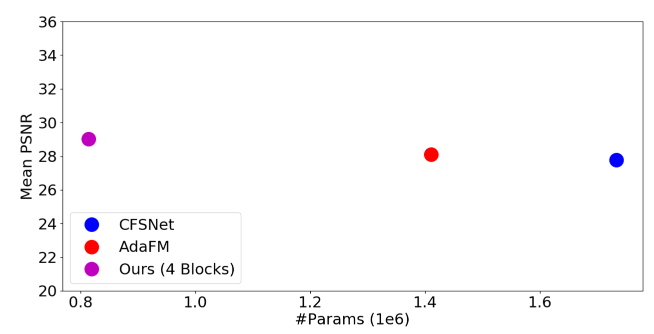


Illustration of the latent space of the weights

Results

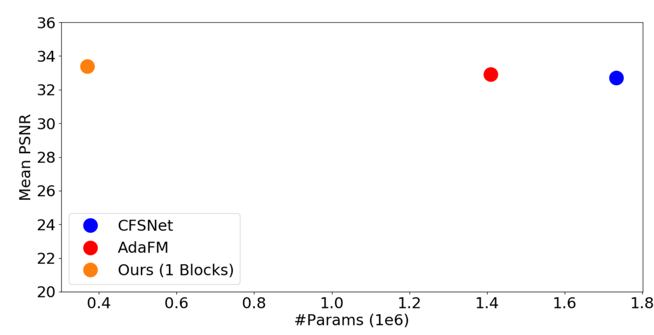
Denoising

	PSNR					
	5	25	45	65	90	Mean
Baseline	40.48	31.42	28.64	27.06	25.73	30.66
Ours	40.39	31.40	28.51	27.06	25.73	30.61



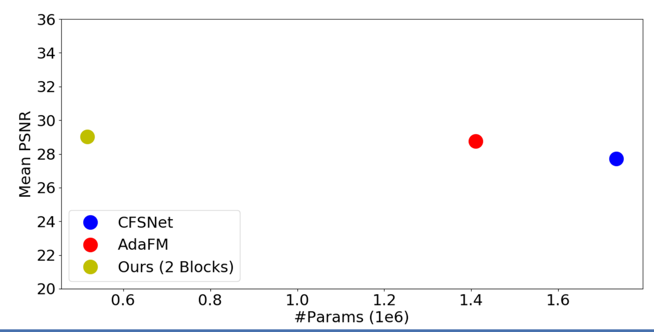
DeJPEG

	PSNR					
	10	30	50	70	80	Mean
Baseline	28.82	32.57	34.40	36.40	38.14	34.06
Ours	28.81	32.56	34.39	36.38	38.09	34.04



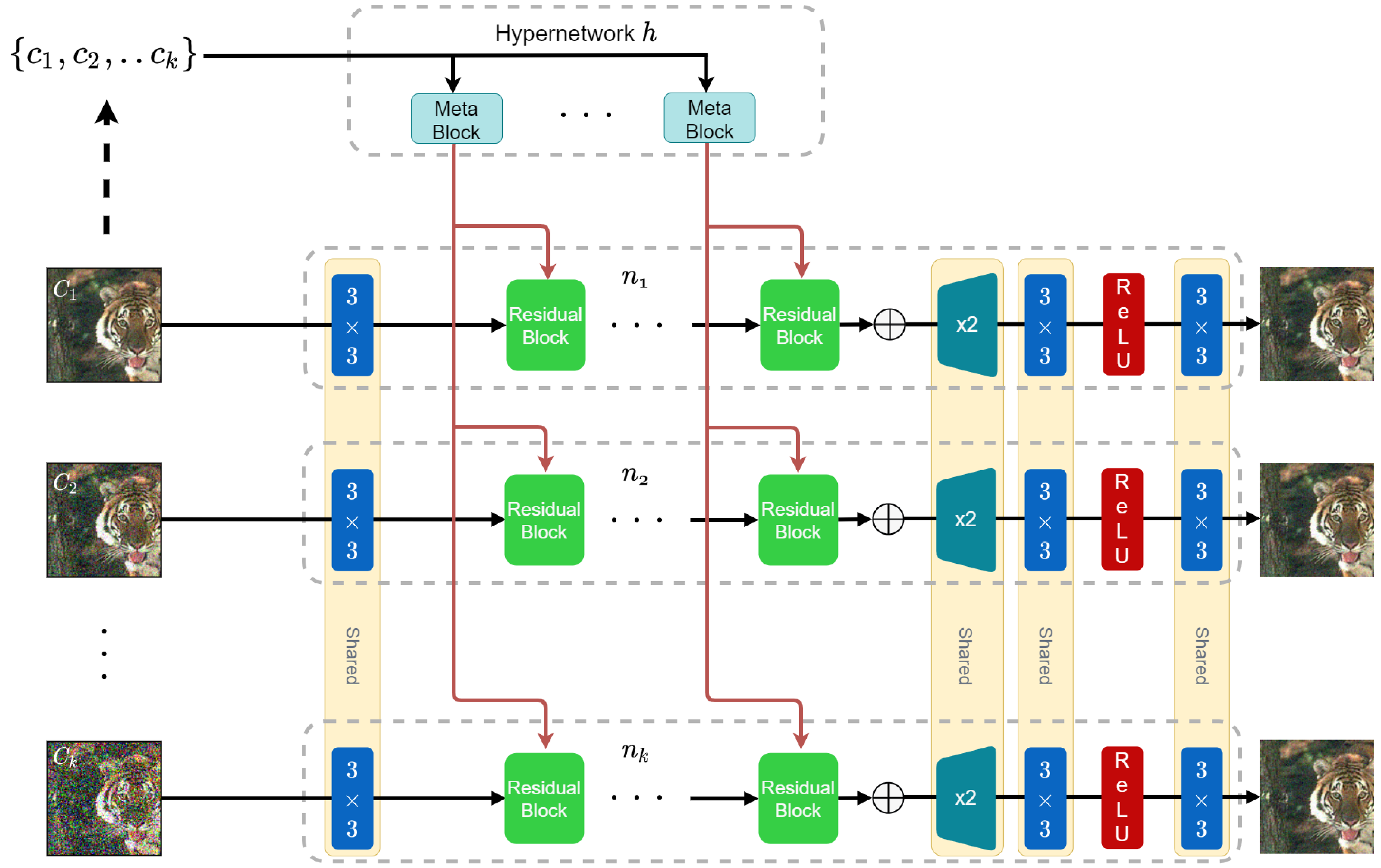
Super-Resolution

	PSNR					
	2	3	4	5	6	Mean
Baseline	36.95	29.86	29.54	25.67	25.06	29.41
Ours	36.71	29.77	29.48	25.63	24.92	29.30



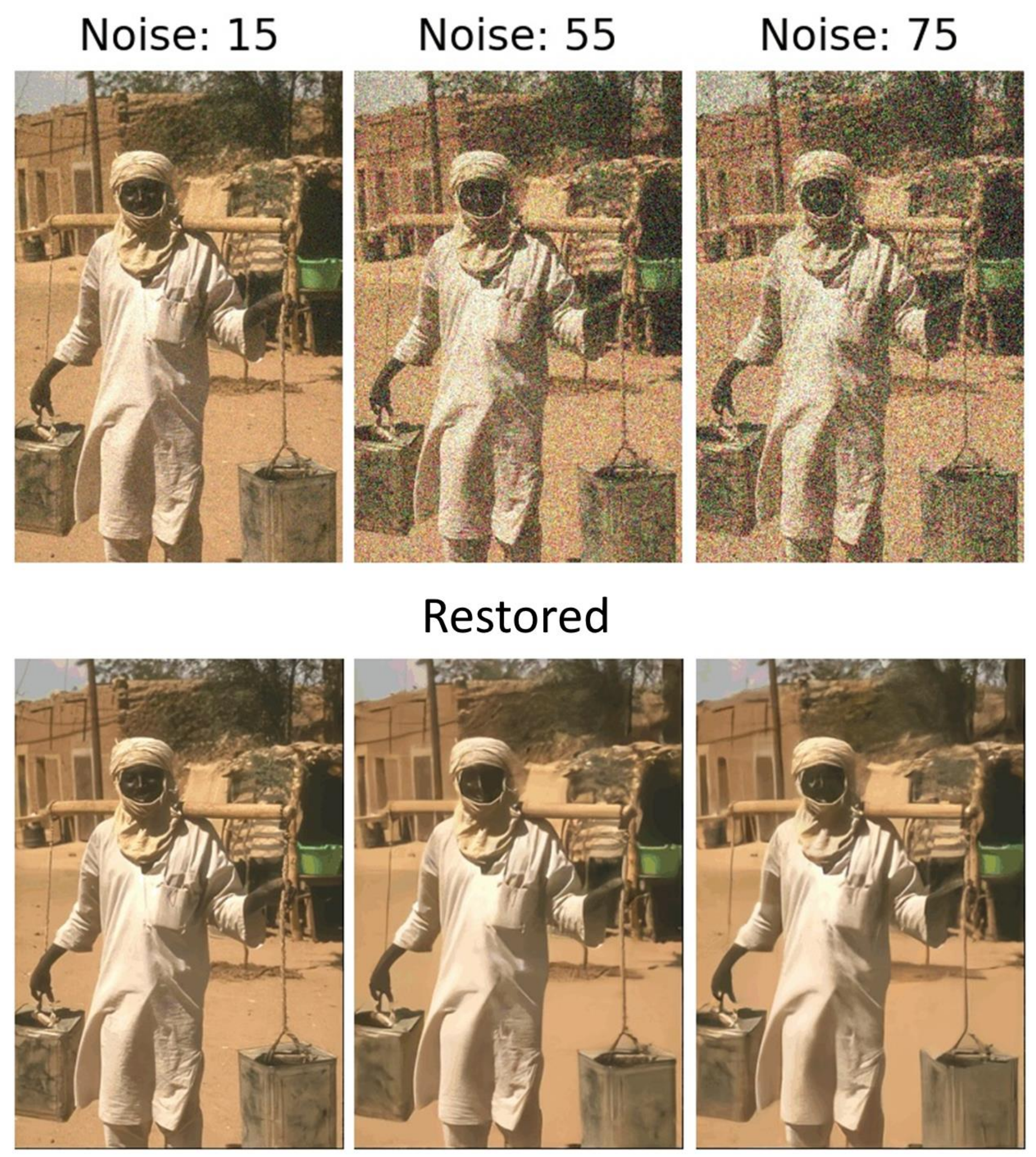
Method

As part of the training process our hypernetwork is optimized with multiple main networks to simultaneously restore images with a variety of degradation levels. The different networks are generated by a scalar multiplication.



Qualitative Results

Denoising



DeJPEG