NSSR-DIL: Null-Shot Image Super Resolution Using Deep Identity Learning

Sree Rama Vamsidhar S[1], Rama Krishna Gorthi[1]

[1]Indian Institute of Technology (IIT) Tirupati, India.

Image Super-Resolution (ISR) : A well-established low-level vision task whose objective is to generate a High-Resolution (HR) image (X) from the given corresponding Low-Resolution (LR) observation (y).

- The current state of the art methods maintain ISR accuracy while being computationally complex and heavily data driven..

Goal of this paper: An efficient and computationally lightweight Image Super-Resolution (ISR) model suitable for practical applications.

Related work:

- Zero-shot approaches using Self-supervised learning

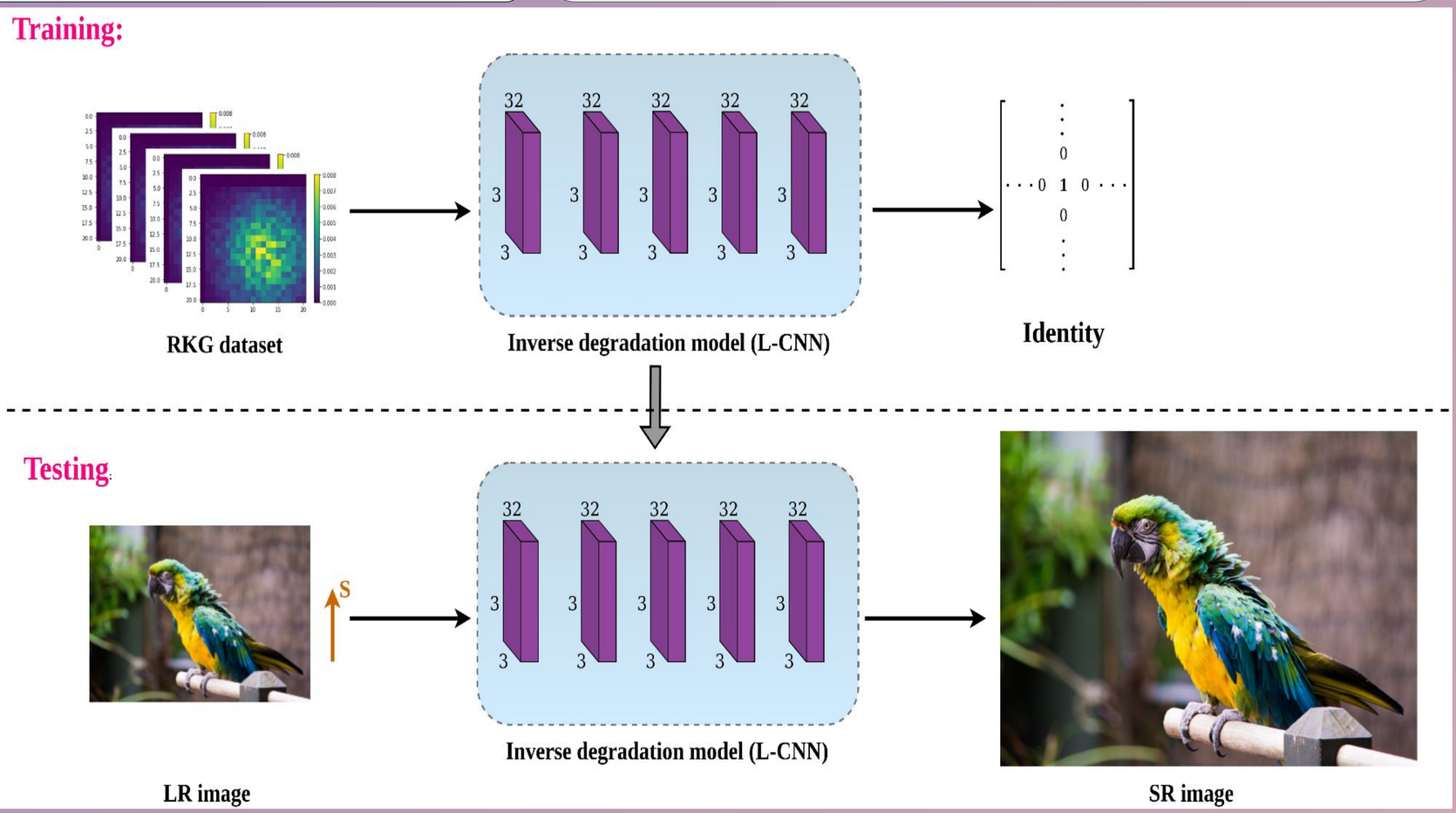
Key feature of this work:

- Thee task of learning the ISR problem from image data is transformed to learning the``**identity (**δ**)"** between degradation model (K) and it's inverse (K^{-1}), based on the linear system concepts.
- This work detours typical degradation kernel estimation step in ISR framework.

Degradation model: $y = (X*K)\downarrow_s$

Inverse Degradation model: $X = y\uparrow^s * K^{-1}$

Identity relation: $K* K^{-1} = \delta$



Loss function - Deep Identity Learning

$$\text{Loss } (L) = \| K * K^{-1} - \delta \|_2 + R$$

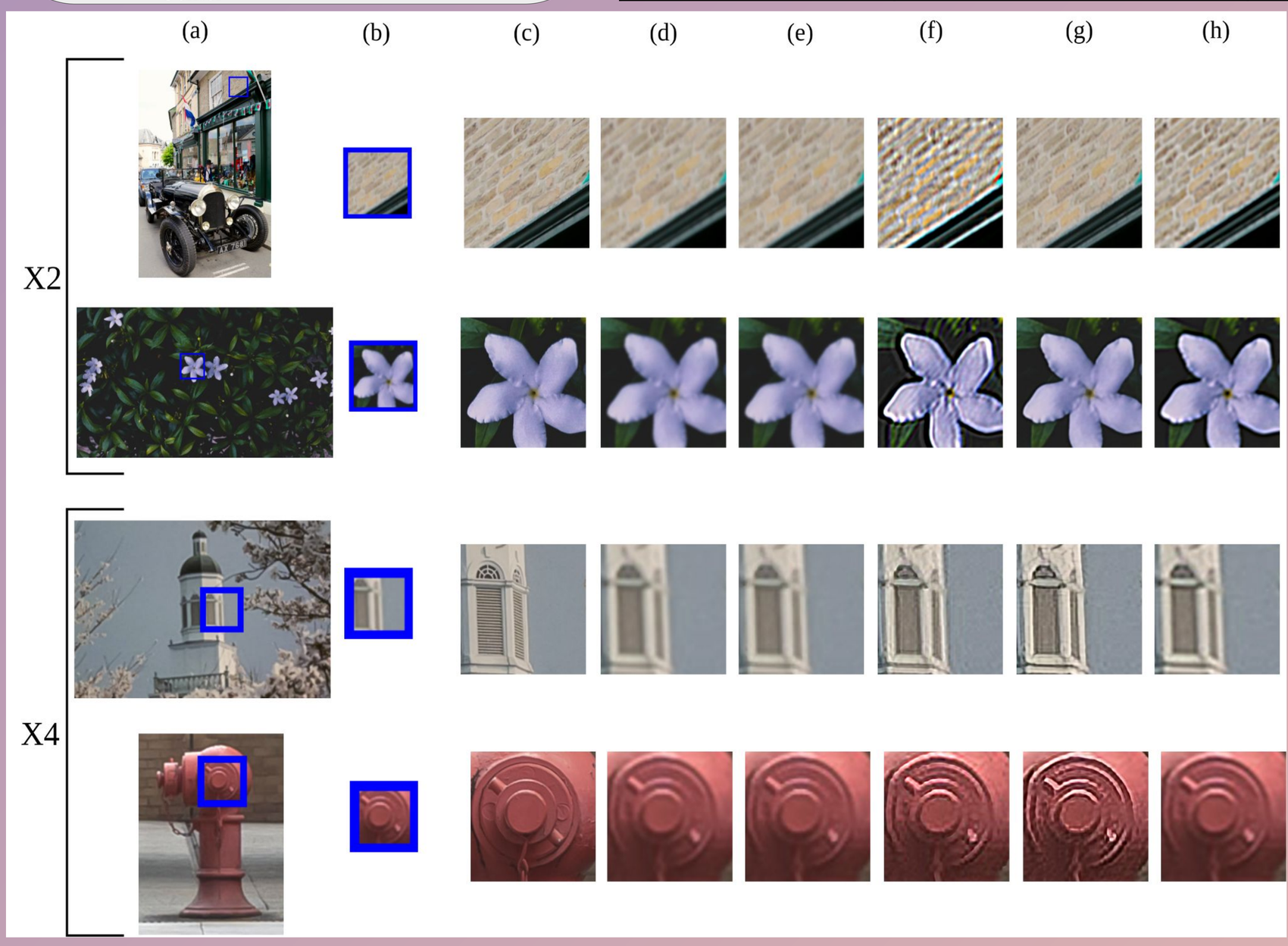
Where

$$R = \lambda_1 \text{ x } L_{ConvArea} + \lambda_2 \text{ x } L_{Center}$$

$$L_{ConvArea} = |1 - \Sigma_{i,j} K^{-1}{}_{i,j}|$$

$$L_{Center} = | 1 - K.(K^{-1})^T |$$

ISR Method (DIV2KRK dataset)	#Parameters (Millions) / Inference time (Minutes)	X2	X4
ZSSR	0.29 / >= 10	4.111/0.7925/27.51	4.156/0.6550/24.05
KernelGAN + ZSSR	0.151 + 0.29 / >= 13	4.071/0.8379/28.24	4.089/0.6799/24.76
DBPI	0.5 / >= 1	4.049/0.8684/30.77	4.146/0.7368/26.86
DualSR	045 / >= 3.5	5.005/0.8538/29.38	-/-/-
NSSR-DIL (**Ours**)	0.028 / 0.005	4.161/0.8644/26.02	4.170/0.7926/23.58



Qualitative results for the scale factor 2 & 4 using DIV2KRK and RealSR datasets respectively. Here (a) - LR image, (b) - LR patch, (c) - HR image, (d) - Bicubic, (e) - ZSSR, (f) - KernelGAN + ZSSR, (g) - DBPI, (h) - NSSR-DIL.

Conclusions:

- The first image data independent DL-based ISR model.
- Addresses the dataset availability, a challenge that is common to DL frameworks.
- A computationally efficient ISR model that super-resolves given LR image, on par with SotA methods, in fraction of second. Hence more suitable for practical applications.

[**ZSSR**] Assaf Shocher et al.: "zero-shot" super-resolution using deep internal learning". In CVPR 2018.
[**KernelGAN**] Sefi Bell-Kligler et al.: "Blind super-resolution kernel estimation using an internal-gan", in NeurIPS 2019.
[**DBPI**] Jonghee Kim et al.: "Dual back-projection-based internal learning for blind super-resolution". IEEE Signal Processing Letters 2020.
[**DualSR**] Mohammad Emad et al.: "Dualsr: Zero-shot dual learning for real-world super-resolution" in WACV 2021.

More details in our paper

Authors:
Sree Rama Vamsidhar & Rama Krishna Gorthi
sreeramvds@gmail.com rkg@iittp.ac.in