JE²Net: Joint Exploitation and Exploration in Reinforcement Learning Based Image Restoration

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Paper ID: 2119

Introduction

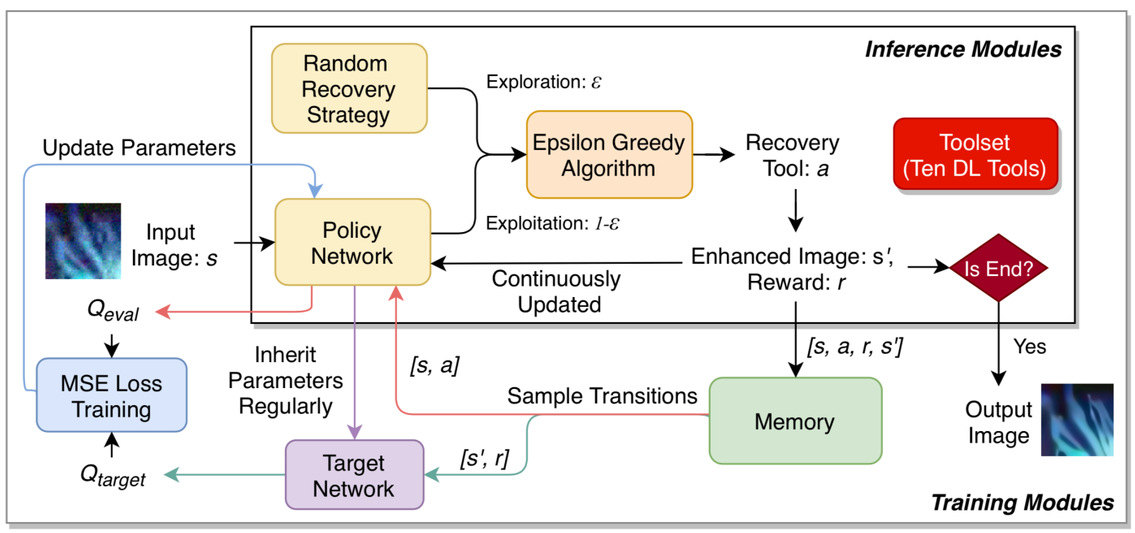
Previous reinforcement learning (RL) based image restoration studies rely on pre-trained RL models with fixed-length paths for restoration, which performs poorly in the case of unknown distortions. To address this issue, we propose to joint exploitation and exploration in the inference process. **Firstly**, we propose a new toolset containing ten CNN-based restoration tools to handle different distortions. **Secondly**, we propose a deep neural network for feature extraction and tool selection, which serves as a model prior. **Thirdly**, we introduce a stochastic strategy to randomly select tools. In this way, the model prior and exploration mechanism are jointly used to expand the search space and obtain more quality gain. **Finally**, a dynamic termination strategy is designed to adaptively stop the recovery process.

Proposed Method

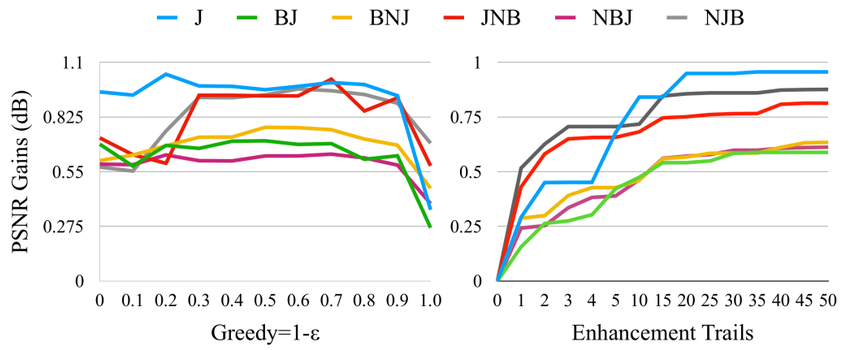
The proposed toolset contains ten tools for different types and levels of distortions.

IDs	Types	Implementations
0	Denoise	DnCNN
1		FFDNet15
2		FFDNet25
3	Super-Resolution	IMDN
4		ESRGAN_{MSE}
5		ESRGAN_{GAN}
6		VDSR
7	Deblur	SRN
8	DeJPEG	DMCNN_{QF10}
9		DMCNN_{QF20}

The proposed framework JE²Net selects tools by the epsilon-greedy algorithm and then recovers the distorted image. This process is repeated until the stopping criterion is satisfied.



Exploitation-Exploration Strategy



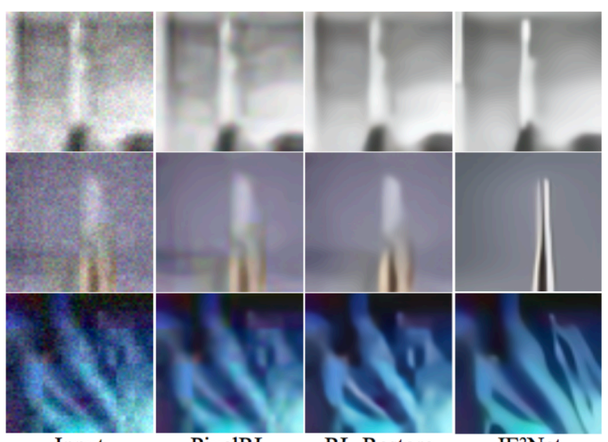
Trends of PSNR gain (dB) for different types of distorted images. Left: Different greedy parameters with trails=50. Right: Different recovery trails with greedy=0.7

Schemes	BJN	BNJ	JBN	JNB	NBJ	NJB
w/o PolicyNet	1.209	0.466	1.309	0.579	0.389	0.693
w/o Random	1.708	0.608	1.856	0.722	0.588	0.570
Path Lengths=3	1.390	0.349	1.507	0.582	0.333	0.635
Path Lengths=4	1.458	0.419	1.570	0.669	0.356	0.720
Path Lengths=5	1.557	0.447	1.605	0.729	0.387	0.797
Proposed	**1.758**	**0.761**	**1.940**	**1.023**	**0.638**	**0.957**

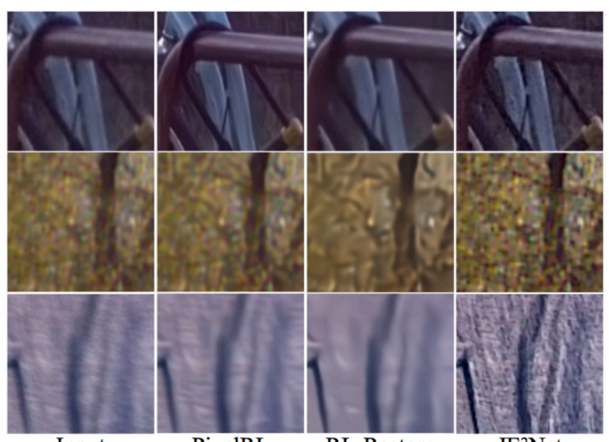
Ablation experiments for various types of distortion. The introduction of certain randomness and longer recovery paths can all lead to better recovery results.

Experiments

Visualization of restoration results on DIV2K and CLIVE distortion datasets.
(a) Hybrid distortion image restoration of DIV2K dataset.
(b) Unknown distortion image restoration on the CLIVE dataset.
The proposed method performs better in terms of block artifacts removal, noise removal and reproduces fine texture details.



(a) Comparisons on DIV2K.



(b) Comparisons on CLIVE.